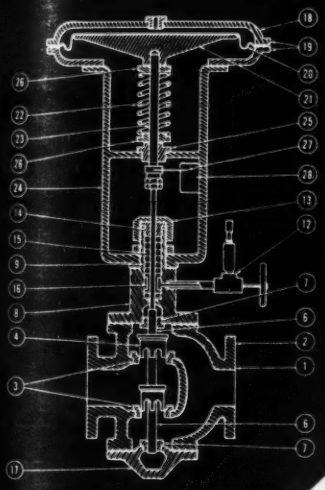
INSTRUMENTS and AUTOMATION

Including: Instrument Manufacturing • The Journal of the SCMA • Simulation Council Newsletter

CONTROL VALVES . . . PAGE 2412

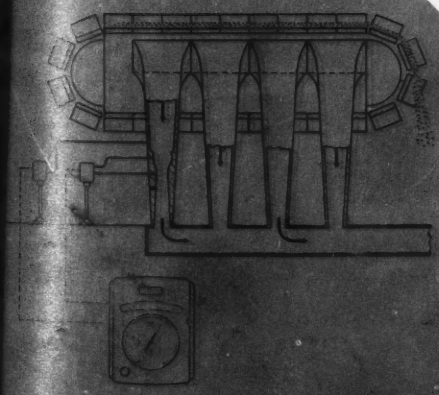


OFFICE AUTOMATION . . . 2426

DECEMBER 1956

Beginning 30 years of service to the field of measurement and control

Vol. 29, No. 12



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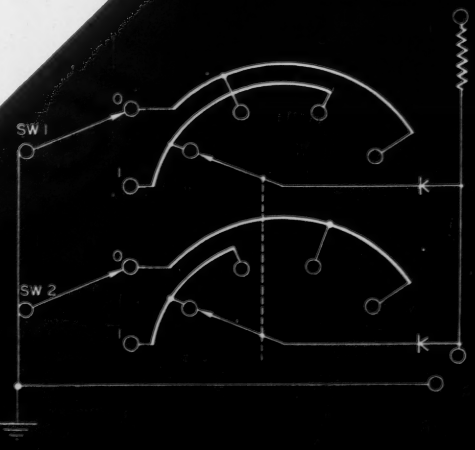
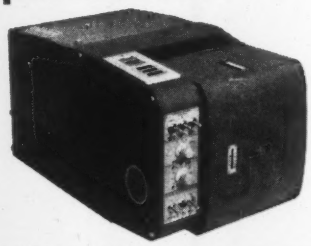


BINARY SWITCHES . . . PAGE 2403

A MIDWESTERN OSCILLOGRAPH
for every recording application

This tabulation shows the many types of MIDWESTERN recording oscillographs available today.



SPECS

Model	Maximum Trace Capacity (1)	Dimensions Inches (2)	Weight Pounds (3)	Record Speed Range Inches/Sec	Record Width Inches	Magazine Capacity Feet (5)	Power Requirements	Timing Lines Sec/Line	Optical Arm Inches	Temperature Range °F	Maximum Acceleration G's	Model
560	14	5¾ x 6⅝ x 7 1/16	8	.375 To 8	3.625	50	28 Volts d.c. 3 Amps Max.	—	6.921	0 to + 160	20 (8)	560
580		7⅝ x 7⅞ x 13½	22.5	.50 To 44.75 (4)		100	28 Volts d.c. 15 Amps Max.	.01 And/Or .10	7.375	—65 to + 190	20	580
581		7⅝ x 7⅞ x 15⅝	28.5									581
544	36	11½ x 12⅞ x 20	75	1 To 50	8	200	28 Volts d.c. 10 Amps Max. or 115 Volts, 60 cps 3 Amps Max.		14.469	+ 32 to + 160	1	544
570	50	11½ x 16⅞ x 20	97		12							570
590	36	11 x 11⅝ x 21⅞	90	.082 To 129.9	7	150	(6)	(7)	11.00	—65 to + 160	15	590
591	50	11 1/16 x 16 13/16 x 24¾	130		12	250						591

FEATURES

Model	Record Numbering	Trace Identification	Automatic Record Length	Timing Line Intensity Control	Galvo Lamp Intensity Control	Record Used Indicator	Recording Malfunction Indicator	Galvo Lamp Burnout Indicator	Timing Lamp Burnout Indicator	Rotary Scanning	Remote Control	Model
560	—	—	—	—	√	—	—	—	—	—	—	560
580	—	√	—	√	√	√	—	√	√	—	√	580
581	√	√	√	√	√	√	√	√	√	—	√	581
544	√	√	√	(9)	√	√	√	√	(9)	√	√	544
570	√	√	√		√	√	√	√		√	√	570
590	√	√	√		√	√	√	√		√	√	590
591	√	√	√		√	√	√	√		√	√	591

NOTES
(1) Using MIDWESTERN 102 Galvanometers.
(2) Dimensions include all external controls and fittings but do not include mating electrical connectors or shock-mount base.
(3) Weight does not include shock-mount base.
(4) A low speed version of these models is available with all recording speeds reduced by a factor of 60.
(5) Listed magazine capacities are with Kodak Linagraph #809 Paper. Other standard recording paper or film may also be used. Larger capacity magazines are available for the 580, 581, 590, and 591 Models.
(6) May be operated from 28 volts dc, 15 amps max.; or 115 volts, 60 or 400 cps single phase, 5 amps max. by means of interchangeable plug-in power supply units.
(7) Timing lines of .001 and/or .01; .01 and/or .10; or .10 and/or 1.0 seconds intervals, by means of interchangeable plug-in units.
(8) A special version of this model is available which will withstand shock accelerations in excess of 1000 gravities.
(9) Timing lines are produced by electronic flasher-tubes. Due to their much longer operating life, warning indicators are not required; and because of their flash illumination characteristic, intensity adjustments are not necessary.

for complete details on the above oscillographs — and other MIDWESTERN test recording instruments and servo components — write

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For more information circle 1 on inquiry card.

at last...

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Never before has *any* analog computing system offered the accuracy, flexibility, capacity and rugged dependability of this spectacular new GEDA A-14 Series Goodyear Electronic Differential Analyzer.

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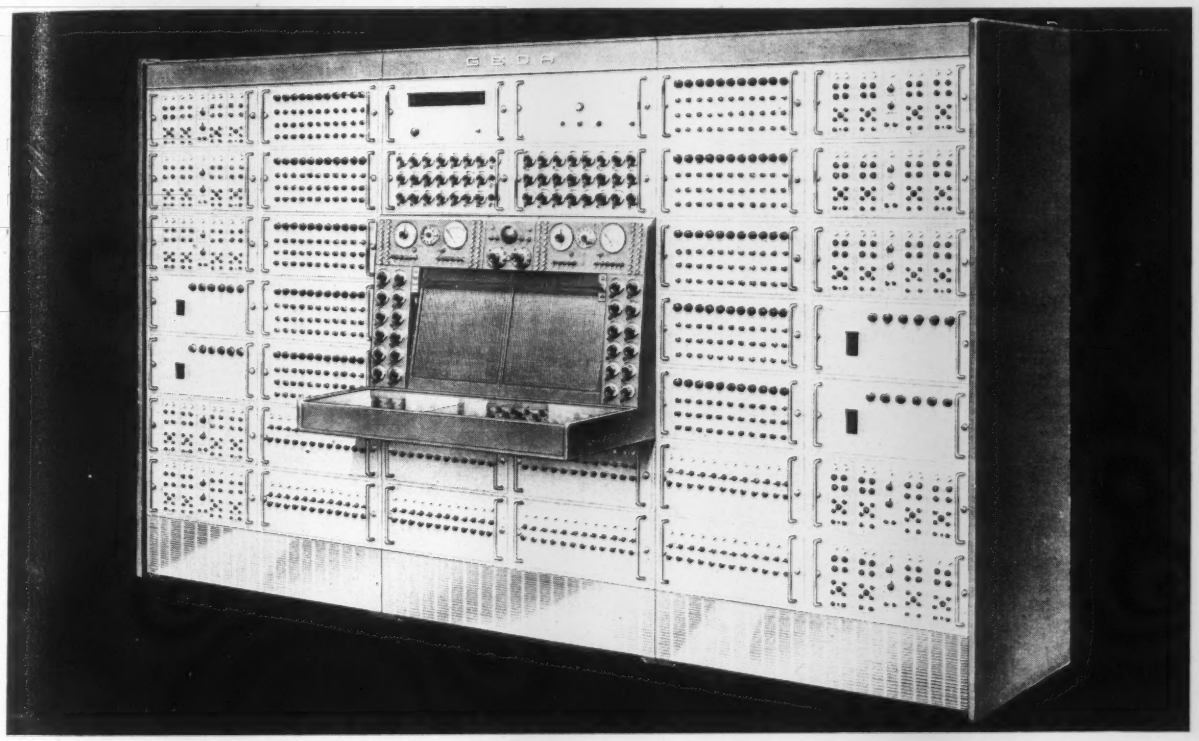

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- ✓ New AUTOMATIC READ-OUT PRINTING to check and record connections and scale factors.
- ✓ New AUTOMATIC DIALING SYSTEM for selecting scale factors and variables.
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a good rule to follow:

for cabinets, instrument panels, weldments, enclosures, cubicles, housings, chassis, consoles—

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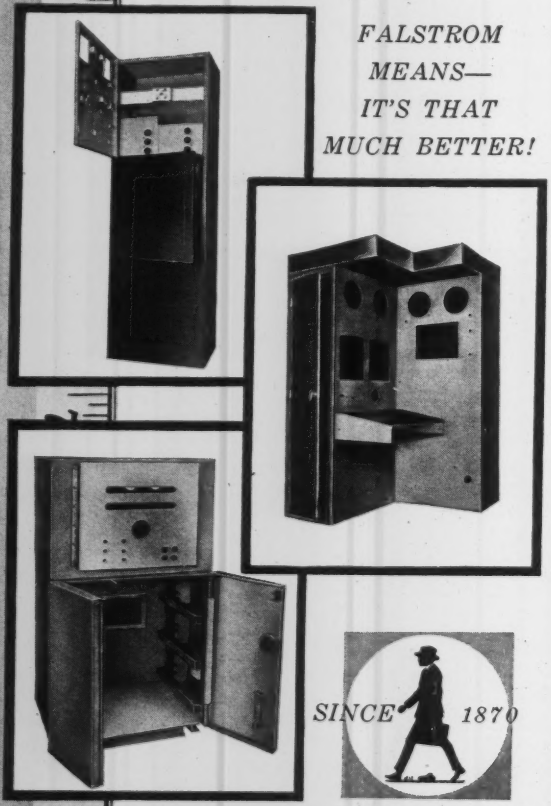
The measure of any company is its reputation—and for 85 years now, Falstrom has been the outstanding name in the sheet metal fabricating field. Under one roof, Falstrom maintains complete design and production facilities including the latest metal working equipment—all backed by men whose experience embraces every type of enclosure requirement. For all work in aluminum, steel and other alloys write for bulletin 142.



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Sensitive Research Diamond Pivots will withstand the tremendous impact of a three foot drop onto a concrete floor without deformation of either pivot or jewel. They assure a virtually "friction free" moving element which will repeat its readings even after abnormal abuse. They are non-magnetic and exhibit no hysteresis effects. Their riding surface can be ground to an ideal .0008". Diamond Pivots are available immediately at a small surcharge in all instruments including ultra sensitive microammeters, millivoltmeters and thermocouple types.

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INSTRUMENTS and AUTOMATION

Volume 29, No. 12
December 1956

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THE MAGAZINE OF INSTRUMENTATION AND AUTOMATIC CONTROL SINCE JANUARY 1928

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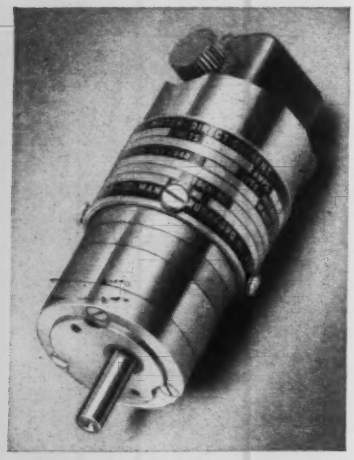
BARBER COLMAN

Gearhead Motors

permanent magnet type with maximum torque output from 5 to 10 pound-inches



Here are permanent magnet gearhead motors that can be used as small actuators to drive switches, programming devices, camera mechanisms, autopilots, flight simulators, and for remote positioning in industrial automation. Ideally suited for variable speed requirements due to extremely stable characteristics over a wide range of supply voltage. The standard Barber-Colman BYLM motor with gearhead, as illustrated, is supplied with outputs up to 1/10 hp and speeds from 5,000 to 20,000 rpm less gearhead. Gear ratios for unit shown are available from 9.5 to 55,446/1. Maximum torque output from 5 to 10 pound-inches (other type gearheads available with outputs up to 500 pound-inches). Send for free technical data.

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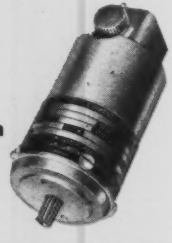

. . . includes both permanent magnet and split series types . . . in various mountings and speeds with outputs up to 1/10 hp. Ideally suited to power electro-mechanical actuators, switches, and programming devices. Also available with gearheads or blowers for special applications. Whatever your problem involving small d-c motors, let Barber-Colman Company engineers help you find the solution. Write for free Catalog F-4344-3.

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INSTRUMENTS and AUTOMATION

Letters to the editor

Editor, I&A:

We are most grateful to have been favored by your splendid address to keynote our Industrial Arts Conference on the morning of October 26. It gave us very definite and enlarged insights into our work and set a tone of growing eagerness for the entire day. Consequently, the Conference was a successful venture from start to finish and everyone appreciated the opportunity to meet with you.

Kenneth W. Brown
Director
State University of New York
College for Teachers
Buffalo 22, N. Y.

Your editor enjoys speaking to educators. Although it may be debated whether the future belongs to the meek and humble or to the strong and wilful, it certainly will end up in the hands of today's students. Thus those who guide our students are more important than those who guide our missiles.

Editor, I&A:

In your magazine Vol. 28, No. 11, November, 1955, pages 1930-1936, you have had an excellent article on the mathematical fundamentals of digital computers.

I have not found a comparable article in the German literature to this date.

I, therefore, would ask you to consent to a shortened translation for one or two Austrian magazines.

Alfred Hogn,
Dip. Kfm. Ing.
Linz on the Danube
Austria

We are pleased to help our Austrian friends. I&A is widely read also in England, France, Italy, Norway, Denmark and Switzerland. We are especially proud of our acceptance abroad—because overseas engineers are highly discriminatory.

Editor, I&A:

In your September issue, there are a couple of items in the "Inquiries" section for which I happen to have answers.

A-139. The Emil Greiner Company of 20-26 North Moore St., New York 13, N. Y. sold us in 1953 several "Bantam" All Rubber Centrifugal pumps with a 1/35 hp motor. The body is of "Hycar" synthetic rubber, not polyethylene; by now they may be making them of polyethylene. (The Greiner Co. also advertises Vantom "Flex-i-liner" pumps with polyethylene construction.)

A-142. The Frenelens Cellular Plastic Optics Dept. of the Bolsey Corporation of America, 118 East 25th St., New York 10, N. Y. has available a stock of molded plastic Fresnel lenses in diameters from 1.3 inches to 15 inches and with focal lengths from 0.83 inch to 19 inches.

Part of my job in this Department is to maintain a large film of catalogs covering any instruments, apparatus, components or material conceivably of use in the researches going on in the Department.

John S. Hopkins
Sr. Laboratory Mechanician
University of California
College of Agriculture
Agricultural Experiment Station
Berkeley 4, California

This letter shows how readers—as well as our editorial staff—help the instrument man with a problem. When an "inquiry" is received here, our staff prepares an answer; then the inquiry is published so that you can pitch in and help. The system works very well.

Editor, I&A:

I am a relatively new reader of your excellent Journal and find your "New Instruments" section and the advertisements a veritable shop window.

Several of our Engineers use your Reader Enquiry Service and I feel that the dissemination of the information would be greatly speeded up by increasing the number of cards per issue to at least three. In this way early readers can retain the time-saving aspect of the Card while

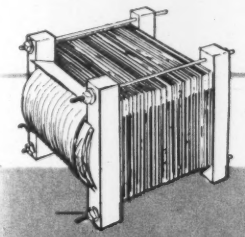
Continued on page 2338

75 years 1881 1956 of Equipment and Systems Engineering

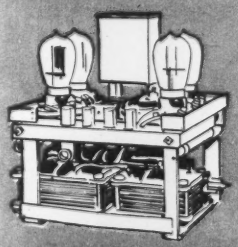
This year, Union Switch & Signal celebrates its seventy-fifth anniversary. It was back in May, 1881, that George Westinghouse, one of America's greatest inventors, organized The Union Switch and Signal Company to design and produce railway signal systems and apparatus.

Since then, Union Switch & Signal has made major contributions to the railroads and industrial control fields in the continual development of better equipment and systems.

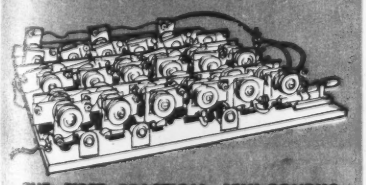
Today, Union Switch & Signal is rapidly branching out into fields where our vast experience in electronics can be put to use. A few of the latest engineering achievements and components are described here.



THE DEVELOPMENT OF THE TRANSFORMER. In 1885, Mr. Westinghouse and his engineers at Union Switch & Signal made intensive studies of a device brought from Europe called a secondary generator. Resulting from these studies was the design of the first practical transformer to be built in this country. This laid the foundation for modern high-voltage, A C power systems.



THE FIRST APPLICATION OF ELECTRONICS outside the field of communication. In 1916, vacuum tubes were used by Mr. L. V. Lewis and other Union Switch & Signal engineers in designing the first inductive automatic train control system. This marked the beginning of the widespread use of electronics in industry.



THE FIRST PRACTICAL SEMI-CONDUCTOR. The first copper-oxide rectifier was built in the Union Switch & Signal laboratories in 1920, under the direction of Dr. L. O. Grondahl. This dry-plate rectifier is recognized as the pioneer in the semi-conductor field which has broadened so much in recent years by the addition of new devices such as the transistor.

SYSTEMS

CENTRALIZED TRANSPORT CONTROL—With UNION Centralized Transport Control, fast and efficient movement of liquids and gases in pipelines is remotely controlled and indicated. Metering, alarm systems, and data handling are made part of the system.

GUIDED MISSILE GROUND HANDLING EQUIPMENT—Missile launcher vehicles, missile transport vehicles, and related electrical and electronic support equipment are manufactured by UNION for the TM-61 Martin "Matador."

FLIGHT SIMULATORS AND TRAINING AIDS—Jet aircraft flight simulators, mass-produced by UNION, realistically create flight situations. Pilot sits in an actual cockpit complete with controls and instruments. Over 10 tons of electronic equipment, mostly analog computers, is used in each simulator.

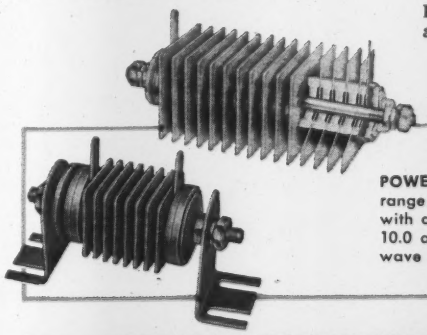
COMPONENTS

MINIATURE RELAYS—UNION AC and DC hermetically sealed miniature relays are recognized as "tops" in electronic and aviation equipment. They offer high shock, vibration and voltage breakdown rating, coupled with long life and reliability.

IMPULSE AND CARRIER EQUIPMENT FOR INDUSTRIAL CONTROL – UNION employs impulse, tone and carrier systems for remote control equipment designed for pipeline, TV elevator, furnace door and other control systems.

RECTIFIERS – UNION copper-oxide and selenium rectifiers, backed by more than 30 years' experience in the dry metallic, semi-conductor field, for commercial applications, offer the utmost in life and reliability. A new UNION development, the RECTALOY* rectifier, proved by models produced in pilot production, is expected to broaden the applications for this type of rectifier.

Trade-mark



POWER RECTIFIERS with solid stack assembly range in sizes from 1" x 1" to 3" x 6", and with convection cooling are rated from .80 to 10.0 amperes per cell on a single-phase full-wave bridge basis.

GENERAL APPARATUS SALES

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DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY

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For more information circle **5** on inquiry card.

Developments in Dynamic Measurement

COSTS NO MORE THAN ORDINARY OSCILLOGRAPHS

Even though the new General Electric PM-20 general-purpose oscillograph has many features not found on comparable oscillographs, it is priced at only $4,200* net.

A WIDE RANGE of frequencies—from d.c. to 6,000 cps—can be recorded at speeds from 0.8 to 100 inches/sec with the new oscillograph.

AUTOMATIC RECORD NUMBERING, timing lines, trace interruption for identification, and automatic record-length control are a few of the many additional features provided for convenient operation.

*Galvanometers and magnet assembly are not included.

PM-20 OSCILLOGRAPH

4 **EASY-ACCESS DESIGN** facilitates fast operation and maintenance. Both galvanometer banks and the gear train are

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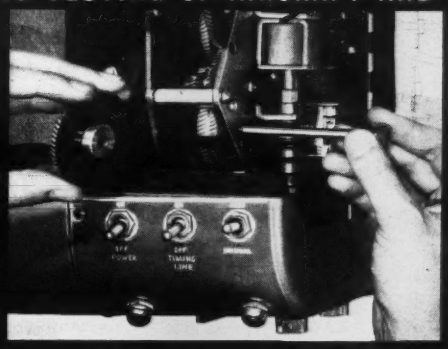
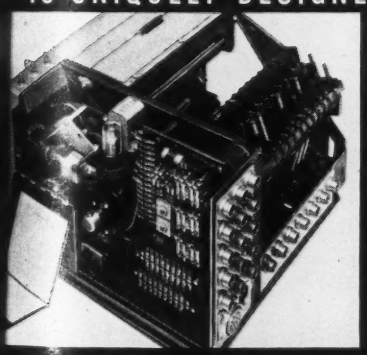


1 **71-GALVANOMETER CAPACITY** in two banks gives versatility in measuring and recording many variables simultaneously.

2 **ONLY 2 IDLER GEARS TO CHANGE** and both are always in use eliminating storage and the chance of loss. No tools are necessary to move the gears.

3 **MAGNETIC SPOOLS** in the record holder simplify loading. The spools automatically position themselves in the record holder.

IS UNIQUELY DESIGNED FOR EASY OPERATION AND MAINTENANCE



readily accessible through hinged doors in the lightweight aluminum case. The entire cover may be removed by loosening three fasteners.

5 **SEPARATE VIEWING LAMP** eliminates adjustments of recording lamp intensity for viewing. Lamps are easily accessible by removing the record holder.

FOR MORE INFORMATION, contact your nearest G-E Apparatus Sales Office or use the coupon above to request a copy of bulletin GEA-6348.

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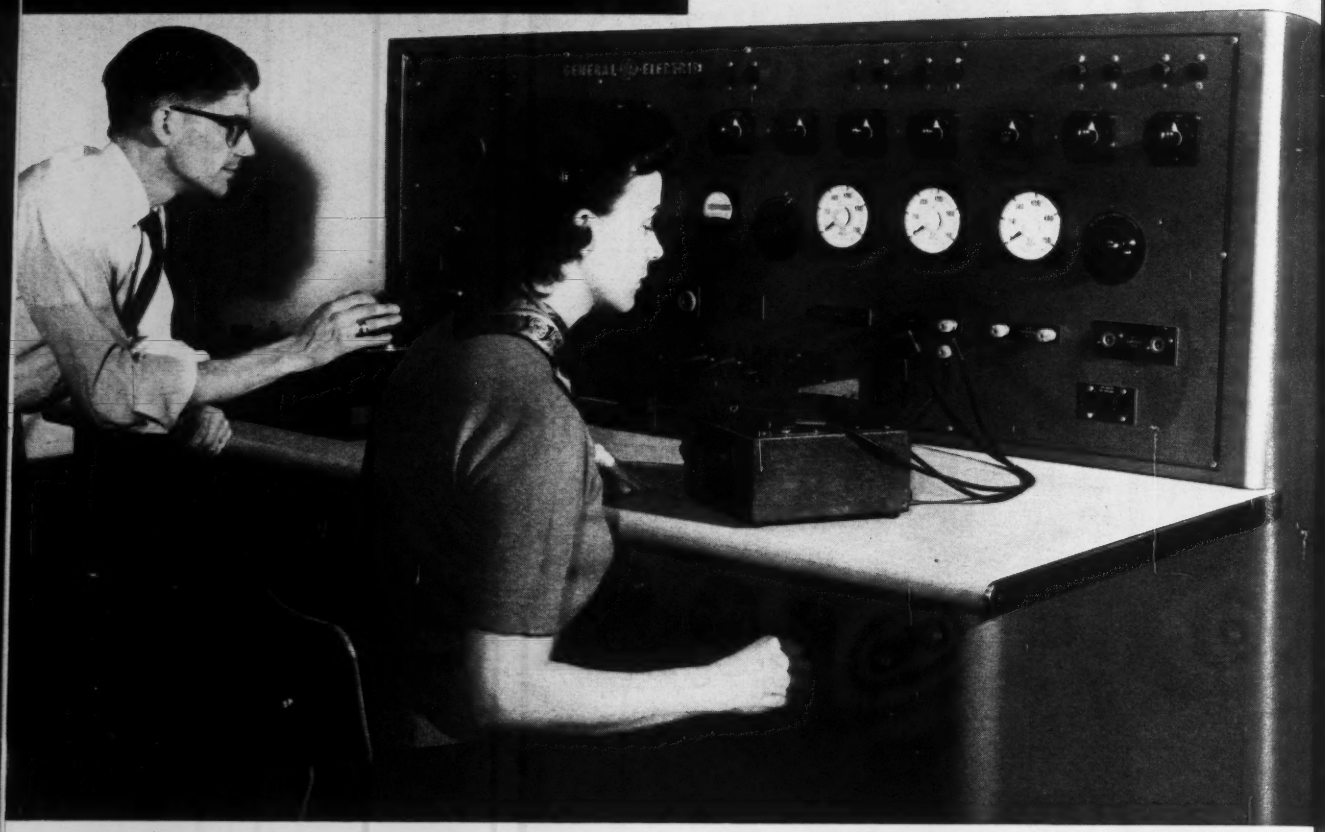
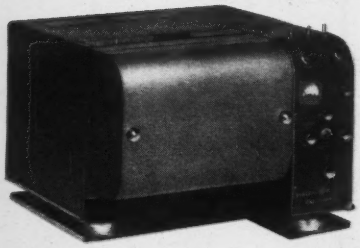


TO SAVE VALUABLE MAN-HOURS, G-E CONSOLE IS FUNCTIONALLY DESIGNED FOR SIMPLE OPERATION; FEATURES EASY-TO-REACH CONTROLS.

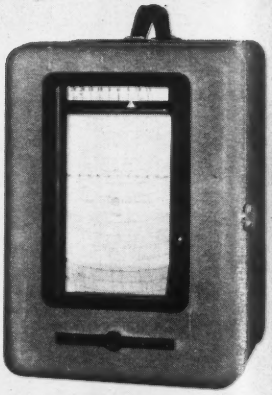
News About Other General Electric Instruments for Precision Measurement in the Laboratory

GENERAL PURPOSE OSCILLOGRAPH



71 VARIABLES can be recorded at one time with G.E.'s general purpose oscillograph. Frequencies ranging from d.c. to 6000 cps can be recorded at speeds from 0.8 to 100 inches per second. Price, $4200.00* plus galvanometers.

PHOTOELECTRIC RECORDER



RECORD RAPIDLY CHANGING PHENOMENA with minimum load on measured circuit. Recorder is available with sensitivity as low as 1 ua full scale. Response times are as low as 1/5 second. $866.00.*

*Manufacturer's suggested retail price.

For more information circle 7 on inquiry card.

Minimize Calibration Time With Versatile, Easy-to-use General Electric Instrument Standardization Console

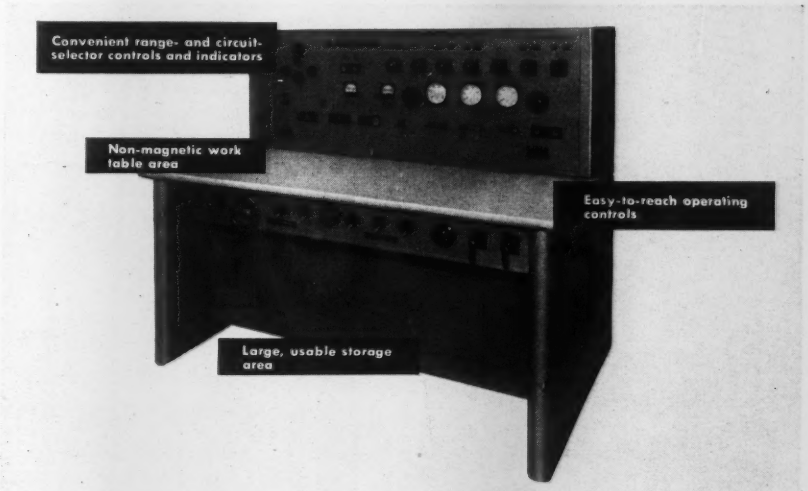
PROVIDES REGULATED POWER SUPPLIES FOR PRECISE INSTRUMENT CALIBRATION

The General Electric instrument standardization console provides regulated power supplies for precise calibration of a wide range of electric instruments.

HIGHLY ACCURATE, the console provides facilities for referring both d-c and a-c measurements to a standard cell, or to a laboratory standard instrument.

WIDE RANGES of a-c and d-c power supplied by the console facilitate the calibration of voltmeters, ammeters, frequency meters, and many others. Both a-c and d-c standardization tests can be made up to 750 volts, or 150 amperes; with low-distorted a-c frequencies from 50 to 3000 cycles.

FOR FURTHER INFORMATION about the General Electric instrument standardization console, contact your nearest G-E representative, or clip coupon below for Bulletin GEA-6005.

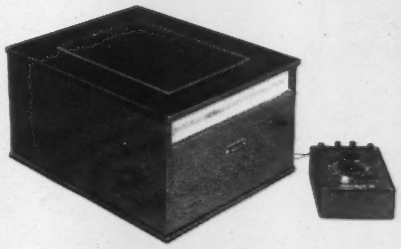

Convenient range- and circuit-selector controls and indicators
Non-magnetic work table area
Easy-to-reach operating controls
Large, usable storage area

HIGHLY VERSATILE, the General Electric console has necessary switches, busses and indicators for calibration of a-c and d-c laboratory-standard, portable, small-panel, switchboard, and recording instruments. Requires only normal 115-v, 60-cycle source.

GAUSSMETER

CONVENIENT, POCKET-SIZE G-E meter facilitates checks of flux density and direction in magnetic gaps. Ideal for use in small or congested areas. Price including reference magnet and case, $90.72.*

INDICATING FLUXMETER



HIGH ACCURACY AND SENSITIVITY combine to provide precise magnetic measurement. Accuracy is ±1% of full-scale deflection; sensitivity is as high as 1 millimeter deflection per 100 flux lines. Price is $299.88.*

SECTION G605-76
GENERAL ELECTRIC COMPANY
SCHENECTADY 5, N. Y.

Please send me the following bulletins:

- ☐ Instrument Standardization Console (GEA-6005)
- ☐ PM-20 Oscillograph (GEA-6348)
- ☐ Photoelectric Recorder (GEC-245)
- ☐ Equipment for Measuring Magnetic Properties (GEC-777)
- ☐ Measuring Equipment Catalog (GEC-1016)

NAME .....

COMPANY .....

STREET .....

CITY ..... ZONE ..... STATE .....

GENERAL ELECTRIC

For more information circle 7 on inquiry card.

RECOMMENDED BY LEADING INSTRUMENT MAKERS

Charging current equivalents up to 200,000 ampere-turns (sufficient to saturate 30 lbs. of Alnico V) are available in the Model 107A and new Model 942 condenser discharge magnet chargers. Both units employ same versatile pulse transformer and wire-wound fixture methods. Adapters for any shape or pole configuration can be supplied to charge all instrument or other permanent magnets made from any magnetic material.

All units are easy and safe to operate and are designed for continuous production use over many years.

The benefits of charging magnets in your own plant or laboratory are well worth investigating.

WE CAN HELP YOU

Our 12 years of magnet charging experience is yours for the asking — send a sample magnet or sketch for free charging analysis.

Write for Technical and Application Data.

Radio Frequency LABORATORIES, INC.
Boonton, New Jersey, U. S. A.

For more information circle **8** on inquiry card.

LETTERS—CONTINUED

avoiding the need to wait for entries from later readers.

J. S. MacKelvie
Electronic Engineer
Peterborough Engineering Laboratory
Canadian General Electric Co., Ltd.
107 Park Street North
Peterborough, Ontario, Canada

Postal regulations say that the area of a page devoted to any type of "tear out" material must be less than ½ of the total page area. So we can give you only two cards. Sorry —rules you know.

Editor, I&A:

The article Control Valve Sizing, in your November issue, is an excellent job that is extremely concise and to the point.

One additional comment may be made on the section titled "Differential Pressure," the last paragraph. In order to minimize certain misconceptions which many engineers have in regard to port efficiencies in a control valve, it might be of interest to quote from a test report which is based on data obtained in our laboratory regarding the effect of different types of plugs in the same valve body, under identical flow, pressure-drop and body-configuration conditions.

"SUMMARY: Use of differentials of unity to 100 psi proves that equal-percentage V-port inner valves and modified linear V-port inner valves have a composite constant port efficiency of 0.60 during inner valve travel. Both linear and equal-percentage contoured inner valves have a varying port efficiency, depending on inner valve travel, of 0.75 to 0.85."

Many engineers, when sizing valves with V ports, do not realize that more capacity is probably available with a contoured plug, with a possible concomitant saving in valve size.

Norman Lieblich
Kieley and Mueller, Inc.
64 Genung Street,
Middletown, N. Y.

Editor, I&A:

According to the footnotes of table 19, page 295 in the 1957 *HANDBOOK AND BUYERS' GUIDE*, there is no instrumentation available for remote reading.

We have developed such a system, a brief description of which follows: Electrodes are clipped externally on an existing gage glass without obscuring vision. No probes are used nor is contact made with the liquid. Level is indicated for the entire length of the glass, voltage output is D.C. and linear. No shock or explosion hazard is presented. Thyratron type relays are also available, any number of which may be applied to a single glass. Relay "contact" point is adjustable anywhere from top to bottom of the glass by a potentiometer on the control panel.

This instrument was developed for a specific job, but now that we have the knowhow, we ask you this question: Do you think that there is a need and a market for such an instrument?

James E. Jones, Mgr.
Industrial Electronics
1906 Seneca Road
Wilmington 5, Del.

We have had several inquiries for "contactless" level recorders and there are certainly many possible applications for such an instrument. A large section of the entire field will learn immediately of your development from this "Letter to the Editor." From this response you will be able to draw certain preliminary conclusions —preliminary because in our competitive society there is no substitute for the great gamble—the decision to market and promote the product.

Editor, I&A:

Please inform me of the approved "Schools of Instrumentation" and their addresses in the Chicago area. Thank you.

E. F. Swartz
Chicago 47, Ill.

Resident Schools include: (1) American Television Institute of Technology, School Division of American Television, Inc., 5050 North Broadway, Chicago 40; (2) Coyne Electrical School, 500 So. Paulina St., Chicago 12; (3) DeVry Technical Institute, 4141 Belmont Ave., Chicago 41.

Correspondence courses are given by others in the Chicago area, which include: (1) Advance Training, 5944 N. Newark Ave., Chicago 31; (2) American School, Drexel at 58th, Chicago 37; (3) Commercial Trades Institute, 1400 Greenleaf Ave., Chicago 36; (4) National Schools, 4000 S. Figueroa St., Los Angeles 37, California or 323 West Polk St., Chicago 7; (5) Sprayberry Academy of Radio, 111 N. Canal St., Chicago 6.

As to quality, the National Home

Study Council, an association of various correspondence schools, has established educational standards for these schools. Quality of resident schools is supervised by the National Council of Technical Schools, Washington, D. C.

Most of these schools give courses on electronic instruments.

The Chicago Section of the Instrument Society of America plans to give courses in connection with the University of Illinois covering "Instrument Operating Principles and Structure" and "Instrument Application in Control Systems." The address is 703 Fisher Bldg, 343 So. Dearborn St., Chicago 4, Illinois. Phone: Webster 9-0686.

Editor, I&A:

Under a project sponsored in cooperation with the Atomic Energy Commission, the Office of Naval Research, and the Air Research and Development Command, this Bureau is preparing a monograph on recording methods for physical variables in research and industry. The aim is to publish a broad survey of existing or potential techniques together with such information on performance as will indicate their usefulness in specific types of applications.

There appear to be elements of novelty in the shadowgraph recorder described in the article by D. L. Supernaw, *Instruments*, Vol. 20, June 1947, page 532. To illustrate the monograph, may be reproduce the figure showing a sectional view of this device?

H. L. Mason
Office of Basic Instrumentation
National Bureau of Standards

You have our permission to use the material on the Shadowgraph recorder (as well as any other material from I&A) in your survey on recording techniques.

Another technique which we were the first to report is the Keinath technique, see April, 1946 issue. Also the Peterson microbalance recording technique, see July, 1955 issue.

1957 HANDBOOK AND BUYERS' GUIDE

Corrections-Additions

The Heading "COUNTERS, Electronic, including Events-per-unit-time" included the term "EPUT" which should have been omitted as it is a Trade Mark of Berkeley Division of Beckman Instruments, Inc.

In the Directory Section add these companies which were omitted inadvertently:

Industrial Development Laboratories, 17 Pollock Ave., Jersey City 5, N. J.

Industrial Retaining Ring Co., 57 Cordier St., Irvington, N. J.

Stromberg-Carlson Company, a division of General Dynamics Corp., 113 Carlson Rd., Rochester 3, N. Y.

The Perkin-Elmer Corp., Main Ave., Norwalk, Conn. was erroneously listed as located in Stamford, Conn.

PRECISION

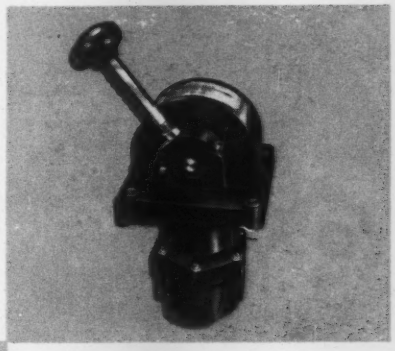
PRESSURE REGULATORS

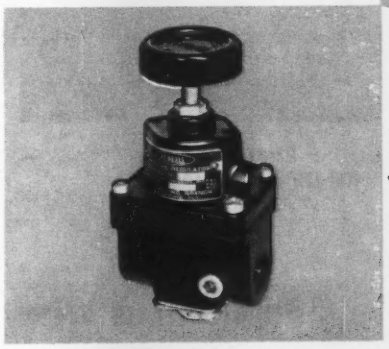
14 models to meet almost all industrial needs.

Send for free catalog.

GOVERNAIRE-pilot operated
KENDALL-direct acting

Now available from the Stratos Industrial Products Branch are two complementary lines of pneumatic pressure regulating valves. Both lines are designed for dead end service. Relief is built in and air consumption is low.





The **Governaire**: Offering very high flows regulated by small signals, the "Governaire" models are self-contained pilot operated, giving precise control even at very large flow rates. (Illustrated is the lever-operated Model 3500).

The **Kendall**: Direct acting, force balanced types, the "Kendall" regulating valves also are available in a wide flow range. They offer the reliability in the direct acting type that the "Governaire" models give in the pilot-operated type.

All models can be completely serviced – including replacement of working parts – without removal from the line. Most are designed for operation at up to 250 psi supply pressure.

AVAILABLE MODELS

GOVERNAIRE

Regulators Model No.	Regulated Pressure Range	Pipe Sizes
1000	½–10 to 2-150	¼ & ⅜ NPT
3500 (Drift-free Lever Set)	½–30 to 3-150	⅜, ½ & ¾ NPT
4000	½–10 to 5-250	⅜, ½ & ¾ NPT
Volume Boosters 1500 (spring biased)	½–10 to 2-150	⅜, ½ & ¾ NPT
	Ratio	
2000	1:1	¼ & ⅜ NPT
4500	1:1, 1:2, 1:3 2:1 & 3:1	⅜, ½ & ¾ NPT
2500 (reversing relay)	1:1 & 1:3	½ & ¾ NPT

KENDALL

Regulators Model No.	Regulated Pressure Range	Pipe Size
10	½–30 to 2-150	¼ & ⅜ NPT
30 (miniaturized)	½–30 to 2-100	¼ & ⅜ NPT
50	20 psi set	¼ NPT
55	0–10 to 2-100	¼ NPT
Volume Boosters Model No.	Range	Pipe Size
15	0–10 to 2-150	¼ NPT
	Ratio	
20	1:1, 1:2, 1:3 2:1 and 3:1	¼ NPT
25 (reversing relay)	1:1	¼ NPT

STRATOS
INDUSTRIAL PRODUCTS BRANCH
A Division of Fairchild Engine and Airplane Corporation
Route 109, West Babylon, Long Island, N. Y.

For more information circle **9** on inquiry card.

Safety for an aircraft test facility at Pratt & Whitney Aircraft Plant, using BS&B Model DV Rupture Discs.

BS&B SAFETY HEADS

Now Handle Even "Tougher" Applications With The New Model DV Rupture Disc . . .

FEATURES OF THE MODEL DV DISC

- ✔ Unrestricted, Instantaneous Opening In Sizes 1" Through 36".
- ✔ Greater Safety — Operates Closer To Disc Rupture Pressure.
- ✔ Minimizes Metal Creep Due To Elevated Temperatures And Pressures.
- ✔ Pressure Ratings: 5 lbs. To Several Hundred Pounds.
- ✔ Temperature Ranges: Sub-Zero To 900° F.

- **High Temperature**
- **Alternating Pressure and Vacuum**
- **Cycling**
- **Corrosive Service**

USE BS&B SAFETY HEADS!

Utilize Our Research Facilities In Selecting Model DV Discs For "Tough" Applications.

BLACK, SIVALLS & BRYSON, INC.

Safety Head Division, Dept 2-V12
7500 East 12th Street Kansas City 26, Missouri

OVER 60 YEARS BS&B RELIABILITY
ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

REPRESENTATIVES AND SALES OFFICES IN THE FOLLOWING CITIES:

Abilene, Texas
Akron, Ohio
Alice, Texas
Ardmore, Okla.
Atlanta, Ga.

Bakersfield, Calif.
Baltimore, Md.
Baton Rouge, La.
Big Spring, Texas
Birmingham, Ala.
Blackwell, Okla.
Boone, Iowa
Borger, Texas
Brookhaven, Miss.
Brush, Colo.
Buffalo, N. Y.

Carmi, Ill.
Casper, Wyo.
Charlotte, N. C.
Chicago, Ill.
Chickasha, Okla.
Cincinnati, Ohio
Cleveland, Ohio
Columbia, Mo.
Corpus Christi, Tex.
Cut Bank, Mont.

Dallas, Texas
Danville, Ill.
Denver, Colo.
Detroit, Mich.
Drumright, Okla.
Duncan, Okla.

Ellinwood, Kans.

Farmington, N. Mex.
Fort Wayne, Ind.
Fort Worth, Texas

Gainesville, Texas
Graham, Texas

Harvey, La.
Hattiesburg, Miss.
Hays, Kans.
Hobbs, N. Mex.
Houston, Texas

Indianapolis, Ind.

Kansas City, Mo.
Kilgore, Texas
Knoxville, Tenn.

Lafayette, La.
Lake Charles, La.
Liberal, Kans.
Los Angeles, Calif.
Louisville, Ky.
Lubbock, Texas

McPherson, Kans.
Medford, Mass.
Memphis, Tenn.
Midland, Texas
Minneapolis, Minn.
Mount Pleasant, Mich.

New Orleans, La.
New York, N. Y.
Nortonville, Kans.

Odessa, Texas
Oklahoma City, Okla.
Omaha, Nebr.

Pittsburgh, Pa.
Portland, Ore.
Powell, Wyo.

Saint Louis, Mo.
Salem, Ill.
Salt Lake City, Utah
San Antonio, Texas
San Francisco, Calif.
Seattle, Wash.
Seminole, Okla.
Sherman, Texas
Shreveport, La.
Sidney, Nebr.
Snyder, Texas
Spokane, Wash.

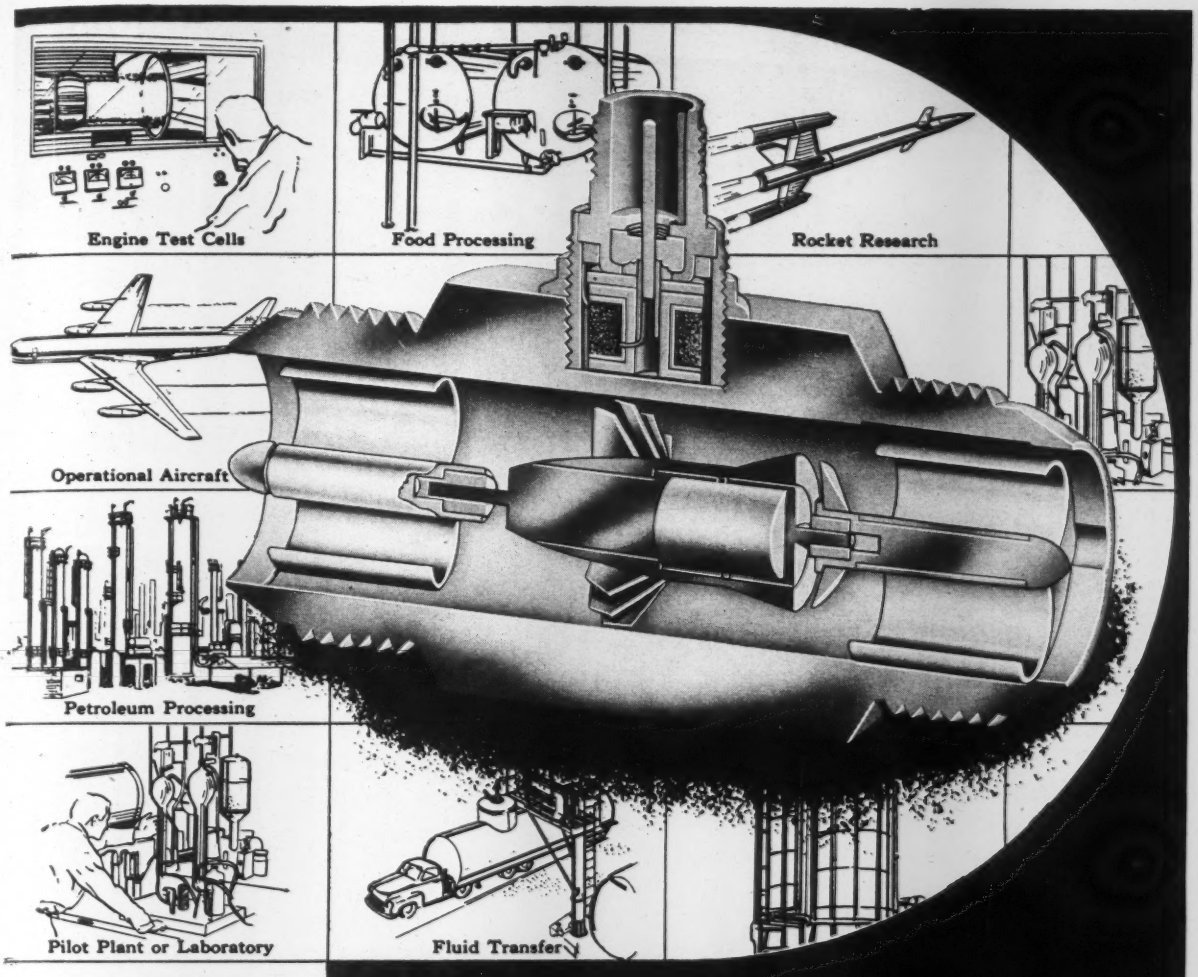
Tulsa, Okla.

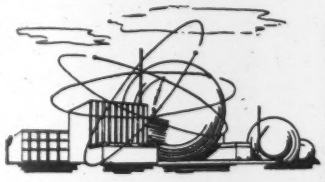
Vernal, Utah

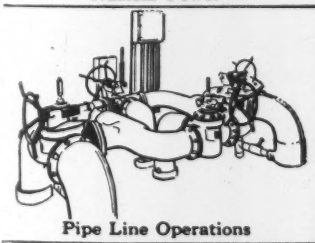
Wayne, Pa.
Wichita, Kans.
Wichita Falls, Texas
Williston, N. Dak.

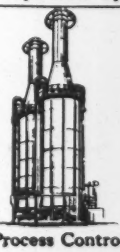
Also Represented In Canada And In Latin America

For more information circle **10** on inquiry card.




Nuclear Power


Pipe Line Operations


Process Control

POTTERMETERS

Complete flow control systems

In every industry where liquid flow information is required, Pottermeters have set new standards of accuracy and reliability.

The only "bearingless" flow meter, the Pottermeter is unaffected by caustics, acids, corrosives and completely reliable even under extreme conditions of temperature and pressure.

Potter engineering has solved many "impossible" flow control problems. Maybe we can help you.

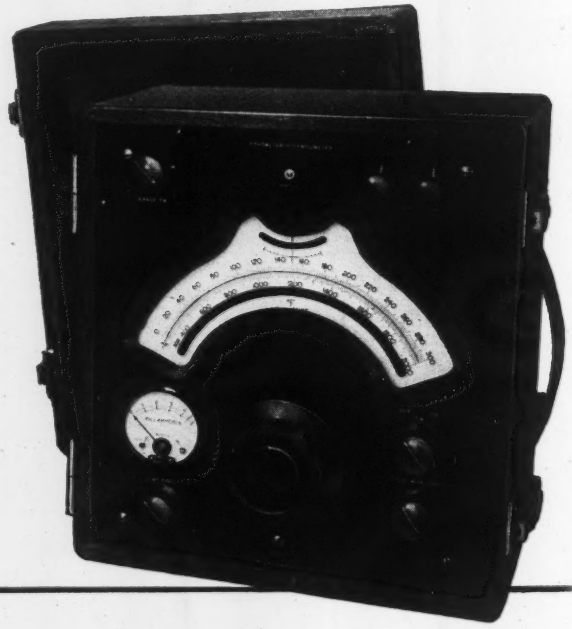
POTTER AERONAUTICAL COMPANY
Route 22, Union, New Jersey

For more information circle **11** on inquiry card.

LEWIS PORTABLE PYROMETER POTENTIOMETERS

FOR MEASURING TEMPERATURES ELECTRICALLY

- **IN MOVING VEHICLES**
- **IN AIRCRAFT**
- **IN THE LABORATORY**



ACCURATE, DIRECT-READING, EASILY-OPERATED INSTRUMENTS, WITH ELECTRICAL COLD-JUNCTION COMPENSATION.

These potentiometers have been used for years by the leading motor car and aircraft manufacturers for proving-ground and flight-test work as well as in the laboratory.

- Three models from which to choose the instrument for your application.
  Model 13PO2, with single temperature scale.
  Model 14PO (illustrated) with high and low temperature scales.
  Model 78PO with one temperature and one millivolt scale or two temperature scales, for different thermocouple materials.
- Housed in a sturdy hardwood case, approximately 11⅜" long, 10" wide and 7⅞" high. Weight approximately 17 lbs., shipping weight 20 lbs.
- For dependable temperature instrumentation, use these potentiometers with LEWIS leads, selector switches and thermocouples.

THE LEWIS ENGINEERING CO.
NAUGATUCK, CONNECTICUT

Manufacturers of Complete Temperature Measuring Systems for Aircraft

For more information circle **12** on inquiry card.

INSTRUMENTS and AUTOMATION Trends

Shippingport, Pa., pressurized water reactor is planned for operation in 1957, the first large nuclear electric generating station in this country. Consolidated Edison of N. Y. and Commonwealth Edison of Chicago "plan" to build power reactors without financial assistance from the Government. Applications for licenses for 10 reactors of various types (including 2 for power generation) have been received by the AEC.

Decca (short-range high-accuracy navaid) system now covers 2 million square miles of Europe. More than 3,000 ships and aircraft use the Decca system. Chains (each chain comprises 4 transmitters) are being used by oil survey companies in Pakistan, Borneo, Persian Gulf, etc.

AEC is moving ahead in its program to broaden private participation in peacetime use of atomic energy. A working group acting under terms of the latest Declassification Guide has reviewed 30,000 classified technical reports and determined that 11,000 could be removed from classification, 8,000 reduced in classification. An additional 310 permits were issued recently to private persons and companies to have access to classified information, raising the total of such permits to 912.

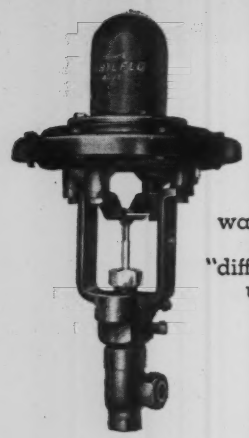
Uses anticipated for the earth satellite include mapping of earth surface, weather charting and forecasting, and worldwide communications.

Use of ITV slow scans (300 scan lines, 60-cps horizontal sweep, 5-second frame rate) results in 8-kc-bandwidth system, permitting picture transmission over low-cost telephone facilities. This should make ITV more attractive, financially, to industrial applications. Technique is reported in AIEE paper CP56-688.

Earliest motors were DC; and early power distribution systems were DC. Modern power distribution systems are AC-owing to development of induction motor and transformer. However, number of d-c motors in use is increasing steadily due to its basic advantage—speed control. Hence new NEMA (National Electrical Manufacturers' Association) Standards for d-c motors and generators are important.

Current $3 billion per year electronic instrument and automation field will quadruple within ten years, says W. A. Ray, President, General Controls Co., who also says that automatic controls alone account for nearly $600 million a year, and is increasing at rate of 15% per year.

GET THE BEST S

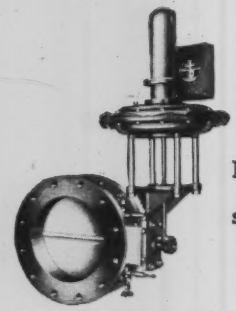


Needle Valves

Rugged, outstanding performers for proportional control of small flows. Interchangeable seat rings and plugs. For water, gas, steam, chemicals. Trim and body materials available for "difficult" fluids. Shown here with unique *reversible* Stabilflo Motor.

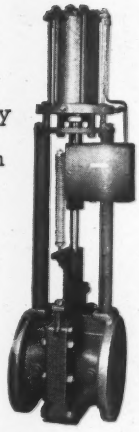
Saunders Type Valves

A complete line, particularly suited to handling of highly corrosive fluids, or fluids containing solids in suspension. Available with Stabilflo Motor as shown, or with Stabiload Cylinder and Power Positioner.



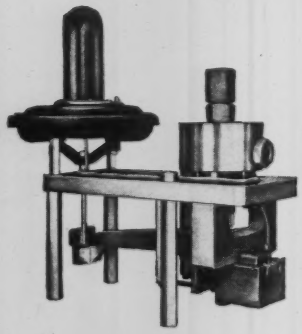
Butterfly Valves

Light and heavy duty types, with angle or swing-through seating, in spool or wafer body style, for low pressure air, gases in combustion control, steam, high pressure gases and liquids, etc. Available with Stabilflo Motor (shown) or cylinder operator.



Gate Valves

Guillotine-type slide valves, specially designed to handle pulp fibre, slurries, and similar fluids. Available with Stabiload Cylinder and Power Positioner as illustrated, for throttling service, or with 4-way pilot valve for on-off service.



Super-Pressure Valves

For throttling or let-down service up to 30,000 psi. Features an exclusive high-pressure bellows seal. Port sizes and connections to meet high pressure process specifications.

FOXBORO CONTROL VALVES

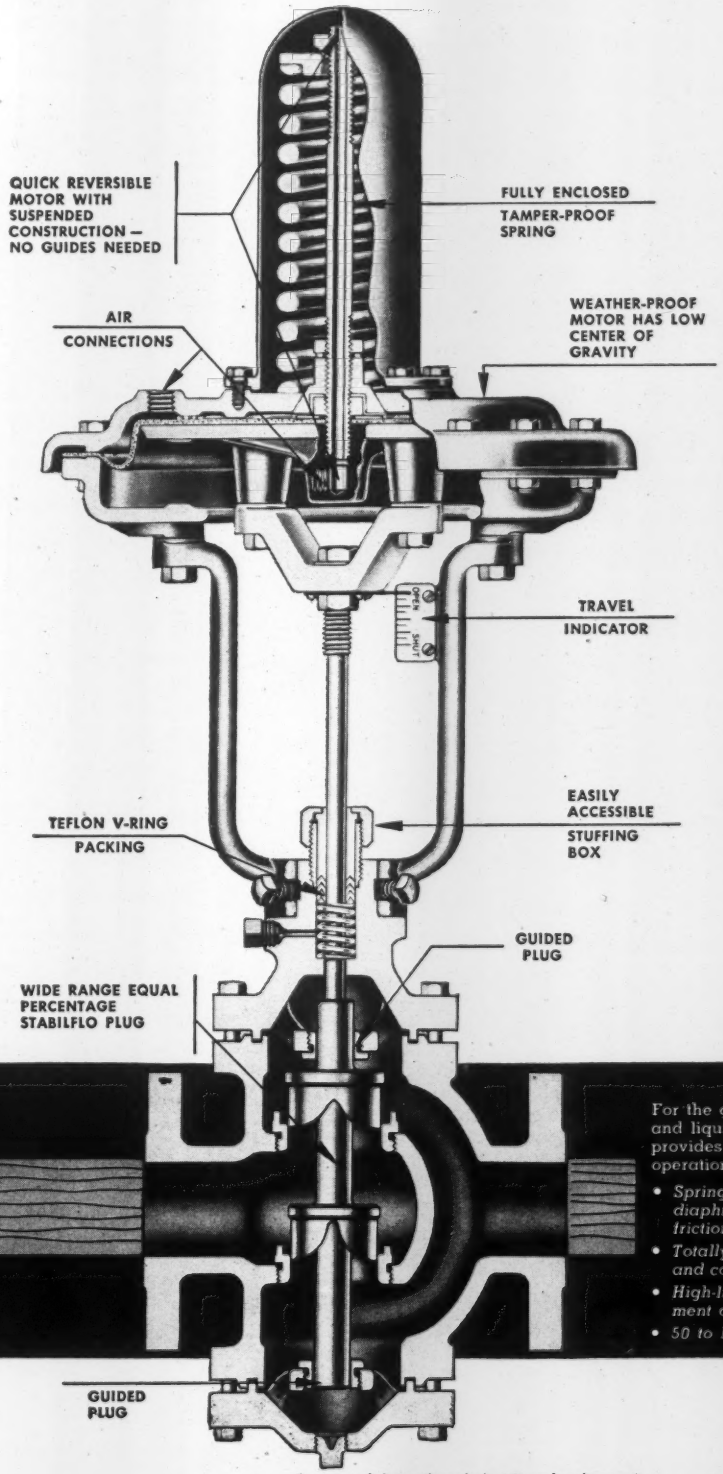
Reg. U.S. Pat. Off.

8 Strategic Branch Shops for Coast-to-Coast Service: **Pittsburgh, Pa. • Chicago (Skokie), Ill. • Dallas, Tex. • Houston, Tex. • San Francisco (San Leandro), Cal. • Los Angeles, Cal. • Montreal, Que. • Vancouver, B. C.**

For more information circle 13 on inquiry card.

SOLUTION TO YOUR CONTROL VALVE PROBLEMS

...with Foxboro Pneumatic Control Valves



You can always be sure of getting the control valve best suited to flow conditions and control actions when you specify Foxboro. No other single source offers such a wide variety of control valves for specific applications. None other has Foxboro's experience in applying them — in every phase of industrial processing.

Your choice extends from valves for simple on-off control at one extreme, to specialized proportioning control at the other; for high vacuum work to operation at 30,000 psi; for temperatures from −350° to +1000°F. And there's a wide choice of plug designs — and of alloys and trim to handle even severely corrosive and erosive fluids.

You can save shipping cost and time, too, buying direct from Foxboro's strategically located branch shops. They're staffed by experts.

A few typical control valves from Foxboro's complete line are illustrated here. For full details, or specific information on your problem, call your nearby Foxboro Field Engineer or write **The Foxboro Company, 4612 Neponset Ave., Foxboro, Mass.**

STABILFLO CONTROL VALVES

For the great majority of temperature, pressure, flow, and liquid level control applications, this basic valve provides unsurpassed sensitivity and troublefree operation. Unique design features:

- *Spring-above-diaphragm construction makes diaphragm motor self-aligning, virtually free from friction and hysteresis.*
- *Totally enclosed spring protects against tampering and corrosion.*
- *High-lift wide range V-port provides greater increment of lift for given change in air pressure.*
- *50 to 1 rangeability - equal percentage characteristics.*

For more information circle 13 on inquiry card.

Where Do These New Concepts Originate?

Panhandle Pete

I was talking with Mr. John L. Wallace, Chief Engineer of the Wallace Electronic Service Company recently about his business when the subject of his new *Aves* Gas Analyzers came up and "Did you like what we did for you in the recent write-up in this magazine?"

"My gosh," he says, "I never saw the likes of it. That story of yours in the August Issue of *Instruments and Automation* brought in so many inquiries that I'm all out of catalogs. Your magazine certainly has the advertising power (ADVT.) and on the strength of all the inquiries we received from colleges, insurance companies and the United States Government I've been to see my banker who is going to loan us more money, I have our advertising agent writing new copy, I've called a board meeting, and I think the chairman is going to propose a general expansion program to enter new fields—computers, programmers and automatic control in general. Along this line we have hired an Operations Research expert and set him up with a new group down in Long Bottom at the Branch Factory to develop our Model O.J. Digital Computer and some new control system he calls a "Big Hot Wind," the one you wrote about in October. (I attended one of these Operation Research conferences in Cleveland during April 5-7, 1955 and frankly, I never heard so much balderdash and hot wind in my life so maybe this expert is right at home.)

"Well who is this guy?" says I, breaking in, "Anybody I know?"

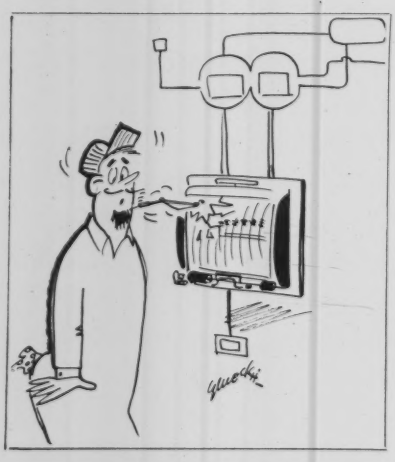
"No, I don't think so. This fellow's name is Herr Doktor Otto U. (Uber) Alles, BS, BA, MA, SB, CORG, JHU, SOB, PHD, ETC and a dozen more he has forgotten about. This fellow has more degrees than a thermometer and blows his top just as easy. He used to be with the engineering firm of Hitchcock, Hancock, Alcock, Peterman, Peterson, Peters and Alles but left them to come with us. On top of all of this he has vast experience all over the world—he says he knows everything and what he doesn't know isn't worth knowing—and has had honors heaped upon him clear up to his, er, navel.

"He is one who might be called eccentric (down at Long Bottom the boys just say he is nuts). Say, what are you doing right now? I'm on my way to Long Bottom to talk with Klapsaddle about his sales force and why don't you come along and meet him."

So I went down and met this, er Doktor Alles. Doc is so highbrow that he can't talk in any language but higher mathematics. As I still find surprises in the multiplication tables, I had a time understanding him. But as his contributions to our field are so very important, I think you should know just where these great new concepts come from.

Doctor Otto U. Alles was born in Ohbieshellendamed, Holland, and during his educational life picked up English over a week-end in London while he was trying to interest the Government in colonizing the moon. "Really old chaps, the sun never sets on the moon either, don't you know?" He also picked up the expression "Old Chap" and uses it all the time.

Doc is a member of AES, AIEE, AIME, AISE, AMHS, . . . SWE plus thirty more in foreign countries. Just a joiner at heart, he tells me his dues run to $34.561.52 a month. Management has him hidden away in this dark room where he is presumably analyzing entire control systems (nobody really knows because they can't understand him).



When we met him, he was reading a copy of *I&A*, but it was upside down. When we asked him, diplomatically of course, about that, he said, "This magazine is so simple rightside up; I like a mental challenge, see? Nor can I understand why anyone uses old-fashioned valves and pneumatic controls when according to my new theory of Electro-Dynamic Transferral of Ultra-Sonic Energy via Intermediate Frequency Fourier Frasmastans all control reactions can be carried out in my little black box. After all, old chap, if you'll take this equation

$$\chi(s)=\int_0^\infty \cdots \int_0^\infty e^{ius} \prod_n g[\eta(i)] \prod_n d\eta(i)$$

and integrate it about a three-cornered vacuum, the above statement is evident and it is also proven thereby that the average unit in operation and the operator as well have no basis for existence."

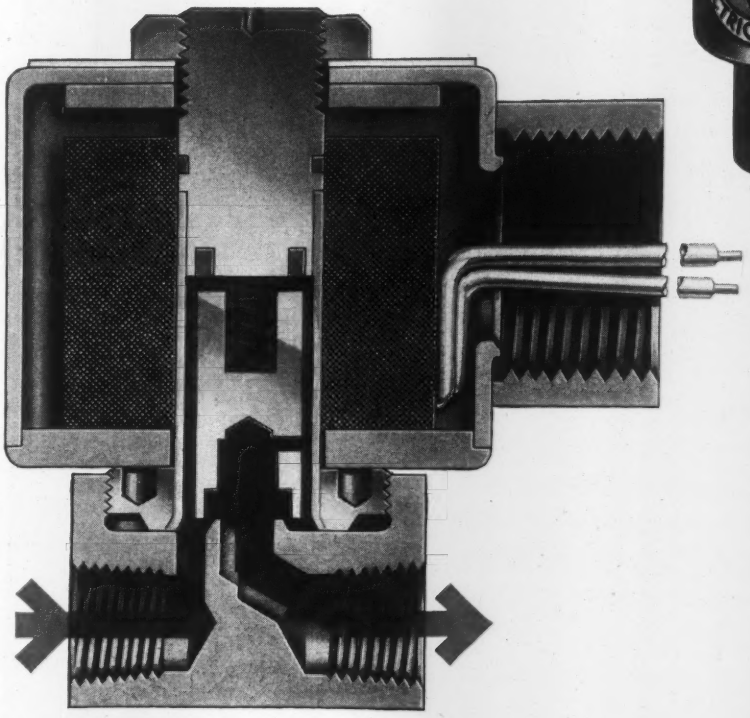
One of Doc's early and most interesting experiences was working with the Never Slip Brassier Company—Our Motto, The Tie That Binds Without Restrain—where he spent many years trying to develop a strapless bra. As discussed in his paper "The Generalized Simplex Method for Minimizing Linear Female Forms Under Linear Inequality Restraints," Doc proved that according to the equation (a basic satisfaction criterion):

$$r=\left(\sum_{d=0}^{d=s} d\ p_d+\sum_{d=s+1}^{d=\infty} s\ p_d\right)\Big/\sum_{d=0}^{d=\infty} d\ p_d$$

it is impossible to hold them up! "Also, old chap, the field work involved wasn't as interesting as you might think."

He has had a few adventures in the steel industry too: Once he went over to the coke plant and almost got run over with the pusher. After this escape he proved in his paper "An Axiomatization of Coke Utility Bases

actual size



New C-series solenoid valve offers recognized "Skinner Quality" at low cost

This is a faithful reproduction – in miniature – of the time-tested, 2-way, normally closed Skinner V5 except that the body is made of brass.

This new, compact Skinner valve weighs only 12 ounces, yet it's rugged enough to last millions of cycles on most applications. It is a packless, direct-acting valve with only two moving parts. And it's absolutely bubbletight – even on vacuum. This C-Series Skinner valve is failproof, too – positive closing is assured by a spring return. It can be mounted in any position and is ideal for direct-line mounting.

You'll find this new valve, with its recognized "Skinner Quality," the perfect low-cost answer to a wide range of flow control problems. It works efficiently with air, water, oils, gasoline and many other media. Typical applications include: automotive fuel systems, welding equipment, vending machines, lubricating devices, spraying equipment, air horns, water softeners, humidifiers and instrumentation.

Our Bulletin D11.1 contains complete information on this valve – flow curves, optional features, dimensions, electrical data, etc. We will be happy to send you a copy on request.

SKINNER ELECTRIC VALVES

SKINNER ELECTRIC VALVE DIVISION
NEW BRITAIN CONNECTICUT
THE SKINNER CHUCK COMPANY

For more information circle **14** on inquiry card.

for digital computers, inventory control systems and tape-to-card converters, also as delay lines, synchronizers and frequency generators.

- Designed to purchaser's requirements
- Guaranteed accuracy of drum runout .00010" T.I.R. or less
- Air bearings or super-precision ball bearings
- Belt drive or integral motor drive, speeds to 100,000 RPM
- Capacities to 5,000,000 or more binary digits
- Vertical or horizontal housing
- Head mounting surfaces to suit
- High density magnetic oxide or electroplated magnetic alloy coating

High Speed Motors, Spindles and Drums

Bryant designs and manufactures electromechanical components for precision operation up to 200,000 RPM, and magnetic drums from 2" diameter x 3" length to 20" diameter x 42" length. If you have a problem in applying high speed rotating equipment to your product, write Bryant today.

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DIVISION OF BRYANT CHUCKING GRINDER CO.

For more information circle **15** on inquiry card.

Panhandle Pete—CONT.

on Subjective Probability of Higher Ordered Metric Scales" that pushing coke is obsolete! It is more efficient to let it burn up and capture all the products, as he has demonstrated in his paper "A Stochastic Model for Synthysis of Alternate Alogarythms Under Finestistic Rational Choice Structures."

Shortly after this he almost fell into an acid tank; this brought out the ridiculously simple fact that the entire by-product plant can be eliminated by vaporizing all liquids with Solar/Lunar energy and then diffusing the vapors in a nuclear reactor as shown by the following equation:

$$P(m,i+1)=P(m,i)\,q(m)+P(m+1,i)\,p(m+1)$$

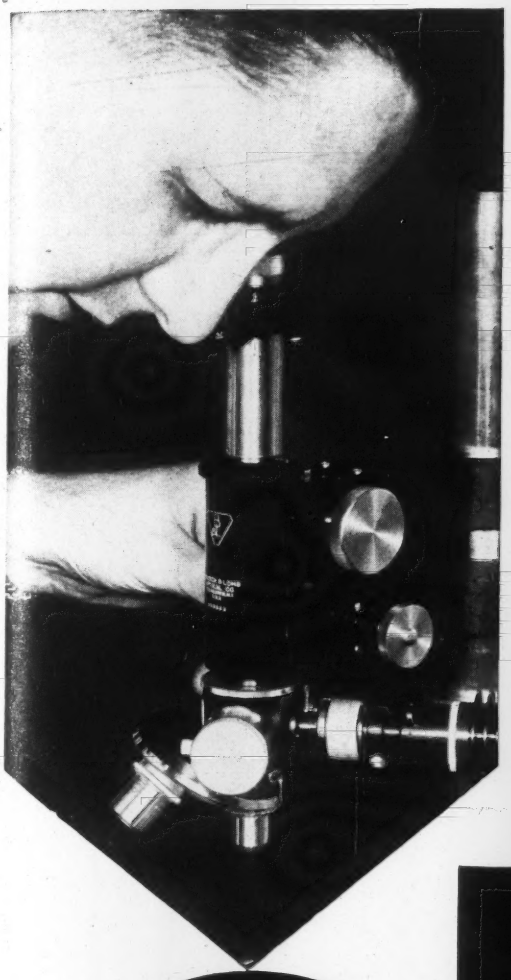
One afternoon, he opened the wrong valve and sent 100,000 gallons of xylol to a customer expecting toluol. Rather than exchange the xylol for the toluol, he proved to the customer that all end uses of toluol can be approximated to the third degree with xylol by the following formula:

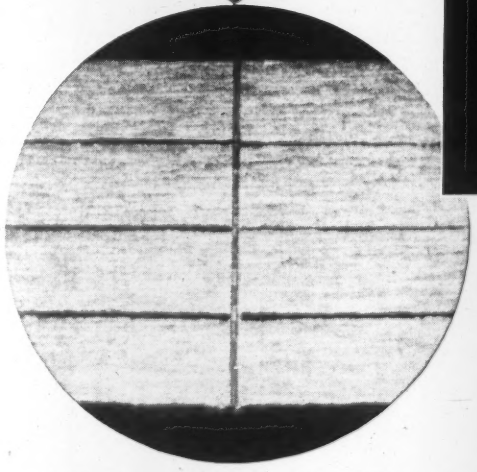
$$P_1^{\,v}=P_{19}\,q^{8(v-1)}+\sum_{j=2}^{8}P_{1j}\,P_{j9}\binom{v}{2}q^{8(v-2)}$$

Furthermore, he proved in his paper "The Computational Beta Ratio Function for the Parallel Parametric Parameters" that the basic difference is wholly imaginative. (PS: the customer still wants toluol.)

As I was leaving after my interview with Doctor Alles, Doc and Klapsaddle got into an argument over the merits of their watches. "All right, old chap, just what time is it?" asked Doc as he pulled out an old, battered pocketwatch without any hands but instead with one hand painted on to read 6PM. "Ha, ha, ha," guffawed Waldo, "You call that a watch?" Looky here at my Little Ben; I have 5:00 PM and as I am always a little slow, it must be about 5:05." "But I say, old chap, you just admitted your watch to be always slow. Therefore, in the true sense of time, your watch is never right. But my watch, with a hand pointing to 6PM is always right twice every day! Simple logic, old chap, proves my watch better than yours. Would you care to purchase mine?" And I'll be darned if Waldo didn't buy that busted watch from Doc. Doctor Alles will go far in our field.

Panhandle Pete





400X enlargement shows high precision gap and track construction.

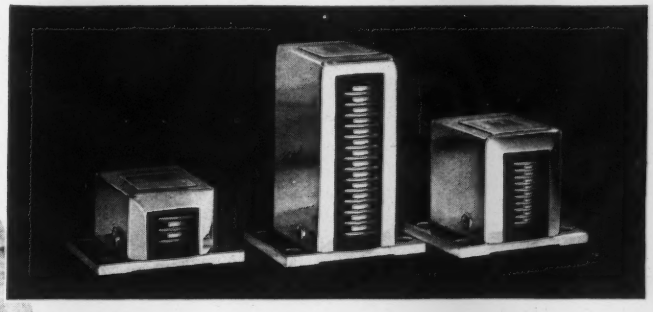
BRUSH *announces...*

NEW PRECISION MAGNETIC HEADS FOR CRITICAL RECORDING APPLICATIONS

Brush now offers a new design concept in multi-channel magnetic heads which provides extremely close tolerances to assure accuracy in recording and reproduction. These heads have already been proven in exacting airborne and missile applications.

ADVANTAGES

- **Uniform output assured by close mechanical tolerances on track width and channel spacing ... ± .002 in. maximum.**
- **Channel-to-channel timing accuracy provided by precise gap alignment... ± .0001 in. maximum.**
- **Crosstalk minimized by full shielding.**
- **Sustained accuracy under severe operating conditions assured by our new construction techniques.**



AVAILABILITY

Brush offers these heads in three designs: providing 7, 8, or 13 tracks per inch. Heads may be interlaced to provide up to 25 tracks per inch. Modifications or new designs using this construction technique may be made to your requirements. Consult Brush on your magnetic head needs—write Brush Electronics Company, Department A-120, 3405 Perkins Avenue, Cleveland 14, Ohio.

BRUSH ELECTRONICS COMPANY

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BRUSH 6 ELECTRONICS

DIVISION OF CLEVITE CORPORATION

For more information circle 16 on inquiry card.

BRISTOL'S INSTRUMENTATION

BRISTOL ELECTRONIC DYNAMASTERS will measure and automatically control any variable — from temperature to viscosity

ANY VARIABLE that can be translated into an electrical quantity – temperature, pressure, pH, voltage, speed, smoke density, resistance, and hundreds of others – can be measured, recorded, and automatically controlled by Bristol's Electronic Dynamaster® Potentiometer and Bridge instruments.

Whatever your measurement or automatic control problem may be, whether it be in the plant, laboratory, or pilot plant, there is a Bristol Electronic Dynamaster for it.

ADVANTAGES of the Bristol Electronic Dynamaster:

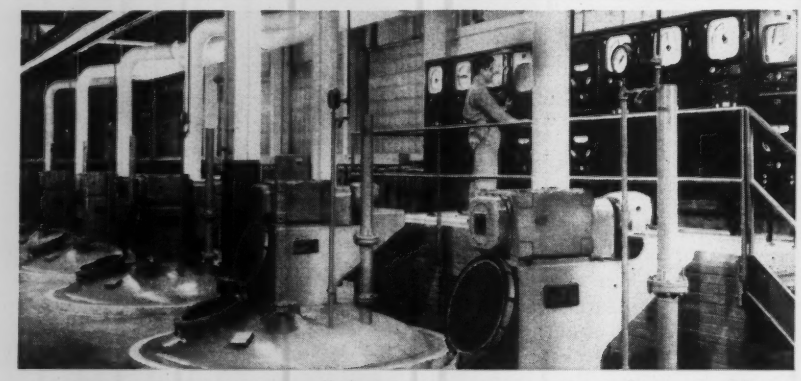
1. Continuous standardization with no dry cells, eliminates need for dry cells and standardizing mechanism – Results: no interruption to control, no batteries to replace.
2. High accuracy . . . fast operation . . . continuous electronic measurement.
3. Simple in design . . . few moving parts.
4. Easy to use and service . . . little or no maintenance required.
5. Flexible in application.
6. Rugged in construction . . . especially built for industrial plants, pilot plants, and for research and laboratory use . . . unaffected by vibration.
7. Plant operating men quickly become familiar with this instrument and like to use it.

MODEL FOR EVERY REQUIREMENT. Dynamaster Potentiometers and Bridge Instruments are available as single-pen, two-pen, and multiple-record (up to 24 points) strip-chart instruments and as round-chart instruments.

ELECTRIC AND PNEUMATIC CONTROLLERS. Both strip-and round-chart instruments are made in a very wide variety of controllers that meet every control requirement, including the following in a great many forms:

Electric Control – on-off, proportional input, 3-position, proportioning, proportional with automatic reset, and time-program.

Pneumatic Control – on-off, proportional, proportional with reset, and proportional with reset and derivative.



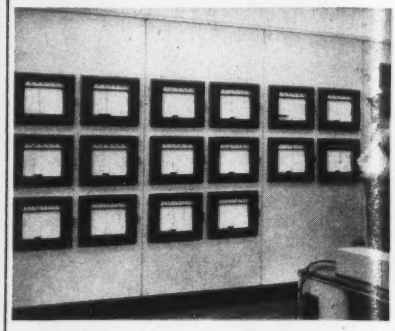
LIQUID LATEX TEMPERATURE is controlled precisely to remove ammonia from natural latex prior to foaming in this plant.

Automatic plant uses Bristol's Dynamaster Instruments

Automation is a reality here at the Buffalo Foam Rubber Products plant of the Dunlop Tire and Rubber Corporation. This automatic plant, designed and built by Mechanical Handling Systems, Inc., Detroit, uses Bristol Dynamaster Electronic Instruments and Automatic Controllers as part of a process employing today's most advanced automatic production techniques. The result – greater efficiency and productivity, lower costs, improved product.

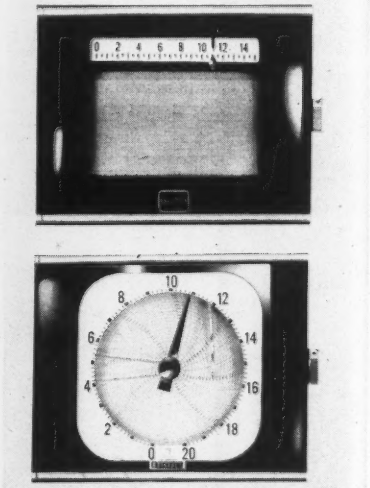
For more information circle **17** on inquiry card.

Sun Oil Plant uses Dynamaster Recorders



Dynamaster Multiple-Point Temperature Recorders are used in the Control Room of the huge new 15-million-dollar Petrochemical Plant of Sun Oil Company at Marcus Hook, Pa. The plant produces chemical grade benzene, toluene, and xylenes.

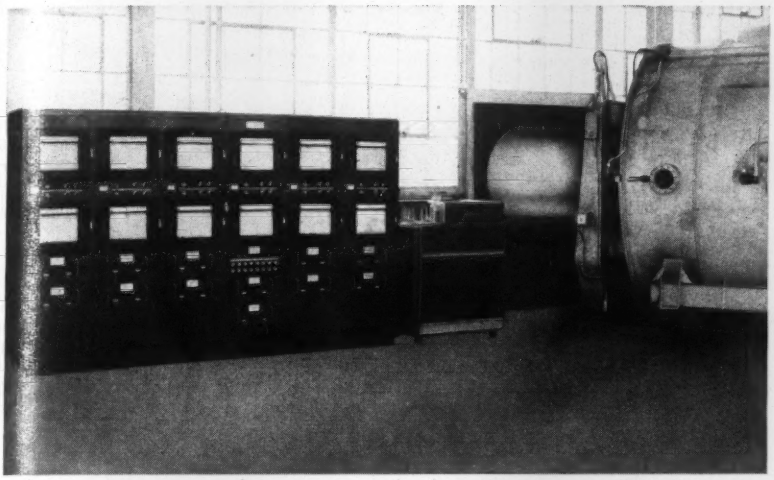
Some of the instruments shown measure the temperatures of feed stock into and out of heaters, at dozens of points. Others record temperatures in cylindrical reactors, where the petroleum molecules are rearranged (reformed) in the presence of the platinum catalyst.



BRISTOL'S DYNAMASTER INSTRUMENTS are available with strip or round chart. Same instrument except for chart drive.

NEWS

. . . news and information about automatic controlling, recording and telemetering instruments from Bristol . . . leaders in human-engineered instrumentation



BRISTOL'S DYNAMASTER INSTRUMENTS are utilized in a Giannini DATEX Digital Data System to record wind tunnel test data both on strip charts and on punched cards.

At United Aircraft Research Dept., Bristol's Dynamaster Recorders not only supply high-speed chart records of wind tunnel tests but feed Giannini DATEX Digital equipment that punches test data on cards, at 100 cards per minute, for analysis by electronic computers.

Dynamasters in this installation record the output of strain gauge pick-ups placed on test models in the wind tunnel. The models are subject to air at supersonic velocities.

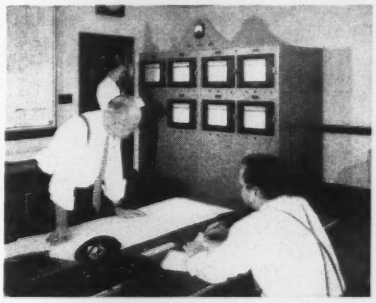
High-speed Dynamaster Recorders (1-second full-scale pen travel) inform test operators of test conditions *between* card punchings. Since the test only lasts from 10 to 20 seconds, it is vital that every bit of information be gathered for analysis.

Dynamasters aid gas dispatching in Midwest

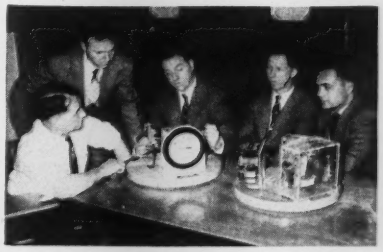
Bristol Dynamaster Metameter Telemeters, at a large midwestern gas utility, help gas dispatchers route gas throughout their distribution system.

These strip-chart Dynamaster Metameter Telemeters record gas pressure at strategic points in the system. This information used to be called in periodically by field men—a slower and less accurate process.

Using the continuous, accurate, up-to-the-minute information supplied by the wide-strip telemeter receivers, the gas dispatcher effects much better pressure regulation in the gas supply than with the old system—particularly during periods of unexpected demand.



Bristol pioneers in automation teaching



Education for automation started at Bristol back in 1920. It began modestly with an instrumentation school for our own sales and service engineers.

Instrumentation was in its infancy then. "Instruments" meant only thermometers, pressure gauges and electrical instruments.

In 1927, we opened our school to customers and their engineers and technicians. The course was expanded to include the principles of automatic control, application of instruments to process control and many other industrial applications.

In 1949, we opened our first free summer training session for professors from engineering schools throughout the country. This program, since repeated several times, was, we believe, the first such ever offered.

Among the subjects studied today are: pressure and vacuum, including liquid level and absolute pressure; telemetering; flow measurements; pyrometers, thermocouples and resistance thermometers; electronic detection, filled thermometer systems and relative humidity; and electrical measurements with voltmeters, ammeters and wattmeters.

→ Write for all the facts

To get the whole story on these rugged precision Dynamaster bridge and potentiometer instruments, write today for your free copy of 36 page bulletin P1245.

THE BRISTOL COMPANY
113 Bristol Road
Waterbury 20, Conn.

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. . WHAT'S NEWS AT BRISTOL... WHAT'S NEWS AT BRISTOL... WHAT'S

For more information circle **17** on inquiry card.

NOW...

a Transistorized

ELECTRONIC PROCESS CONTROL SYSTEM

'American-Microsen' presents a new all-electronic process control system with...

Transistorized instruments.

All measurement and control functions contained in just three basic units.

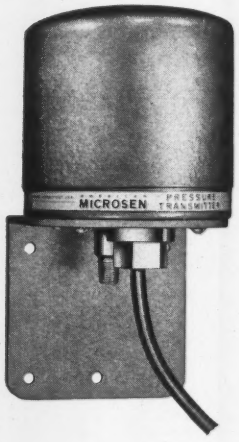
Each unit contained in a single, compact housing.

The *transistorized* electronic Controller has all control room components within one, panel-mounted case. *Transistorized* for highest reliability and compactness, this new instrument saves both panel space and wiring... means better process control for a smaller investment.

These new instruments supplement the many 'American-Microsen' Process Control Systems that have been in continuous and successful operation since 1953.

Write for the new 'American-Microsen' Control System Bulletin for more information about how these instruments can provide the ultimate in process control, product quality and economy.

THE TRANSMITTER



The new Series 185 Pressure Transmitter is a miniaturized version of the well-known 'American-Microsen' Pressure Transmitter. It incorporates the latest mechanical and electrical features to achieve maximum operating benefits and usefulness.

The time-tested "Microsen" balance creates a stable dc signal for long distance transmission. Bearing pivots and linkages are entirely eliminated. Consequently, sensitivity is practically infinite, and repeatability of measurement is within 0.001% of range span.

Printed circuitry and miniaturized components reduce the size of the transmitter to only 4⅞" in diameter and 5¼" high. In dust and weatherproof case designed for universal mounting, the Series 185 can be firmly supported on meter piping, pipe pedestal or vertical surface.

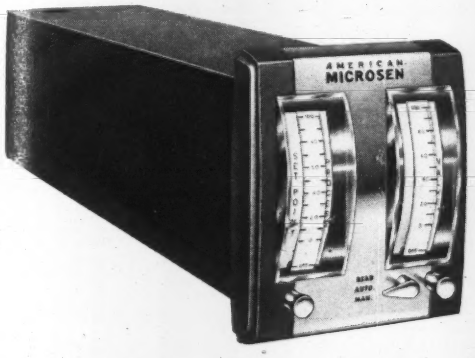
'American-Microsen' Transmitters of similar design are available for differential pressure, flow, temperature and other variables.

MANNING,

MAKERS OF 'AMERICAN-MICROSEN'

For more information circle **18** on inquiry card.

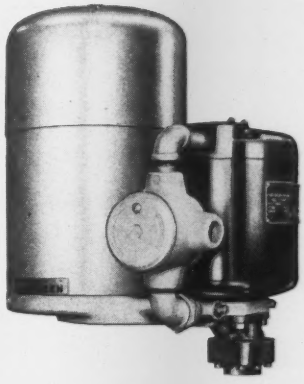
THE CONTROLLER



The Series 164 Controller provides a complete controlling system in a single panel-mounted housing. Now one compact transistorized unit handles *all* control functions: indicating or recording the process variable, controlling, and manual-automatic operation. Transistorized design greatly improves reliability and service life. Savings in panel cost are tremendous because of miniaturization and consolidation of control functions – because no longer is it necessary to wire several units externally.

The Series 164 is available as a Recording Controller, compact Indicating Controller and as a long-scale Indicating Controller. Each functional unit is contained on a separate plug-in chassis within the housing. Each unit can be removed and replaced within moments without disturbing the operation of the other units.

THE OPERATOR



In 1955 we introduced the 'American-Microsen' Electro-Hydraulic Control Valve Operator – a power unit with position feedback to operate control valves, dampers, etc. It completely eliminated the need for compressed air.

More than a year of efficient performance in field service was paralleled by further engineering developments that culminated in the new Series 181 Electro-Hydraulic Control Valve Operator. This improved unit offers simplified design characteristics that mean even lower cost and greater reliability than its predecessor.

The Series 181 Electro-Hydraulic Control Valve Operator is mountable on standard yokes supplied with conventional slip-stem control valves with bodies of single or double-seated construction, with V-port, parabolic, needle and equal-percentage plugs. It can be furnished for all valve sizes, including those of 4″ stroke, and with force available up to 3,250 lbs.

MAXWELL & MOORE, INC.

INDUSTRIAL CONTROLS DIVISION

Stratford, Connecticut

ELECTRONIC INSTRUMENTS FOR MEASUREMENT, TRANSMISSION AND CONTROL

MAXWELL MANNING M&M MOORE INC. TRADE MARK

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INSTRUMENTS and AUTOMATION News

Principles & Applications 2354 to 2365
Stock Report 2365
New Plants & Mergers ....2369 to 2370
People in the News .....2372 to 2374

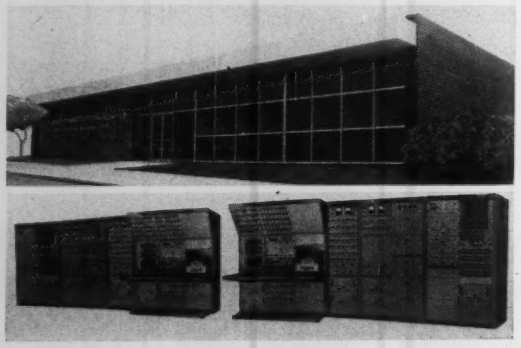
Computer Vs Sports Experts

REDONDO BEACH, CALIF.—ALWAC, Logistics Research digital computer, topped a panel of sports experts 3 to 1 during a televised display of its knowledge

of baseball, football and horse racing. Master of ceremonies was Dr. Martin Klein (co-author of *I&A's* "Digital Automation" Series). Panel members accepted their defeat with sporting good humor, insisting they were distracted by the MC's beautiful assistant "Miss Adventure."

Western Computing Center

LOS ANGELES, CALIF.—An open house, held Nov. 9, marked opening of the new Electronic Associates Computing Center for western industry, business and science. Arrangements to use the twin-unit system are



negotiated on either an hourly fee or contract basis, with the center making available its staff of engineers, mathematicians and analysts for cooperative work with clients' engineers. The center emphasizes active participation of the customer's personnel in each step of the problem solution, including operation of the computing equipment, as a valuable indoctrination in analog computing techniques and their application to problem solution.

Printed-Circuit Forum

CINCINNATI, OHIO.—The Formica Company held a successful Printed-Circuit Forum at the Netherland Hilton Hotel in Cincinnati, Ohio on October 30, 1956. More than 300 representatives of the entire electronics industry were present at this discussion of this fast-growing new field of printed-circuits. In the well-balanced program the entire technology was reviewed by leaders in the field covering the printing, etching, electroplating, component insertion, and soldering of printed-circuits. The nine speakers presented an up-to-date view of this expanding technology from many viewpoints.

Magnetics Conference and Exhibit

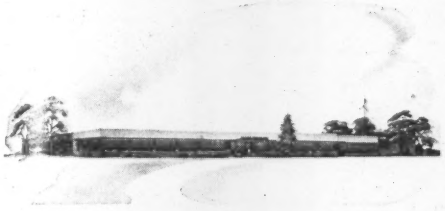
BOSTON, MASS.—The second national Conference on Magnetism and Magnetic Materials, sponsored by AIEE in cooperation with APS, AIME, and IRE was held October 15 through 18, in Boston, accompanied by an Exhibit (managed by Richard Rimbach Associates). Presentation of seventy-five papers and presence of 14 exhibitors contributed to an outstanding success. Conference Chairman was Dr. R. M. Bozorth of Bell Telephone Laboratories.

Heidelberg Conference

HEIDELBERG, GERMANY.—Germany's international Conference on Control Technique sponsored by a joint committee of VDI (Mechanical Engineers' Society) and VDE (Electrical Engineers' Society) was held in Heidelberg in September with several Americans participating.

Shown in the top picture is Prof. R. O. Oldenburger (Purdue University) expressing the thanks of the conferees from U.S.A., while Prof. Broida of the French AFRA is pictured having the same pleasant task in the lower picture. In the center of both pictures (folded hands) is the chairman of the Conference, Dr. Otto Grebe. Other participants came from Austria, England, France, Germany, Holland, Israel, Italy, Japan, Russia, Sweden, Switzerland, and Yugoslavia.

WHY SETTLE FOR LESS?



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WHEN YOU SPECIFY POWER SUPPLIES

. . . you are entitled to all of the benefits of complete facilities, thoroughly experienced engineers, wide product range, prompt delivery and competitive prices.

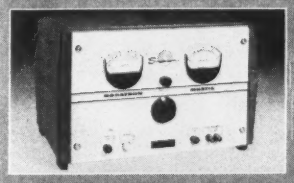
WHY SETTLE FOR LESS?

Take a standard DC requirement, anywhere between 6 and 1000 volts. You need a good, reliable standard DC source — you want to be able to install it and forget it. You want it promptly and, since it's a standard item, you want it for a reasonable price.

If you investigate Sorensen's "Nobatron"* group — more than 70 models available "off the shelf" — and look a bit deeper than the electrical and mechanical specs, here's what you'll find:

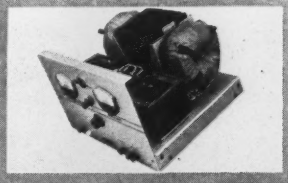
**Reg. U.S. Pat. Off. (NO BATTERIES — ELECTRONIC CONTROL)*

THE OUTSIDE APPEARANCE —



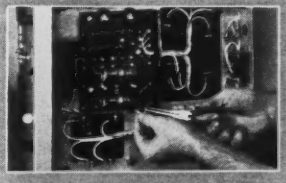
clean, functional, careful attention to small details. Not always vital, but indicators of quality design, workmanship, and materials.

INSIDE, TOP QUALITY COMPONENTS —



rugged construction — sound engineering proved by tens of thousands of successful units.

NEAT, UNCLUTTERED WIRING —



firm, long lasting connections — hallmarks of skilled people. You don't learn this workmanship overnight, but it's the key to a reputation for precision.

IF WE CAN MAKE A COMPONENT BETTER, WE DO.

If somebody else can do it better, more economically and faster — like we make power supplies — we buy it. Either way, it means better quality for you.

THE ACCUMULATED EXPERIENCE OF SORENSEN'S ENGINEERING STAFF —

***specializing* in power control — is more than 215 man-years. That means less "second guessing," less engineering time, faster delivery, lower cost. And better units.**

OUR SALES ENGINEERING STAFF AND MANUFACTURERS REPRESENTATIVES

work together to put all of these facilities, all of this experience, at your immediate disposal. All it takes is a phone call.

In short, don't just buy "a power supply." Whether it's a precision regulated source for a special job, or a standard low cost unit, *start* with Sorensen . . .

Sorensen®

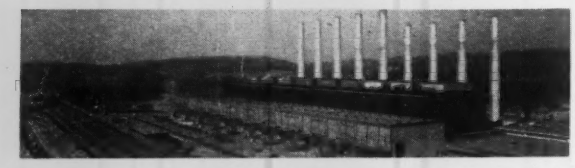
SORENSEN & COMPANY, INC. 375 FAIRFIELD AVE. • STAMFORD, CONN.

In Europe, contact Sorensen-Ardag, Eichstrasse 29, Zurich, Switzerland, for all products including 50 cycle, 220 volt equipment.

For more information circle **19** on inquiry card.

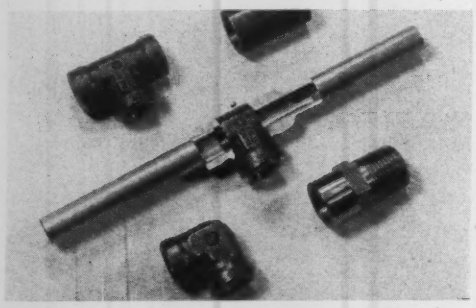
The Story Behind "Weld-Lok"

KINGSTON, TENN.—The TVA powerhouse and switchyard at Kingston, Tenn., is the world's largest power plant, having a capacity of 1,600,000 kw. Operating temperatures of 1050°F, steam pressures of 2000 psig,



and feedwater discharge pressures to 2300 psig caused much leakage around ordinary tubing fittings. A partial solution was found in welding the standard fittings—but making up the standard fitting and then welding it was both time-consuming and expensive.

An engineering study was undertaken by TVA, and it was found that a tapered socket fitting could be assembled and welded more rapidly than a threaded fitting. With production design work handled by engineers at the Parker Appliance Company, Cleveland, the one-piece

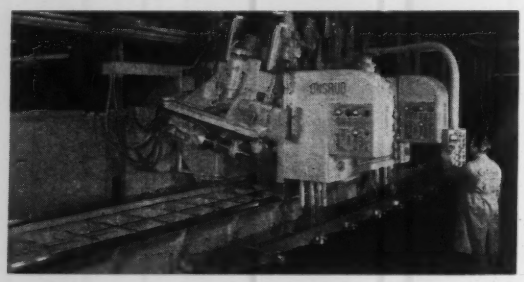


tapered-socket tube fittings, commercially labeled WELD-LOK, are now available in a range of sizes and materials.

The cutaway view shows a "before" and "after" welding. Tapered socket aligns and holds tube before welding, and seals end of tube so that welding slag or flux cannot enter flow line. Note how finished weld completely fills space between tube and socket, without voids. Result: a permanent joint unaffected by thermal shock or vibration, providing smooth flow passage.

Tracer Control of Spar Milling

SCHENECTADY 5, N. Y.—One to twelve simultaneous or individual cutter-feed motions on a 90-ton universal spar milling machine can be directed by a new GE electronic tracer control system. Application of the



machine will be in the processing of spar and wing chords and wing skins requiring a wide variety of machine cuts. Control is engineered to provide simultaneous rise and fall, transverse, and twist motions. Normal set-up uses multi-purpose tooling fixtures which allow almost complete machining of a part before it leaves the stationary workbed. A selsyn is connected to the cutting head while another is following a cam or template to be duplicated. The resulting position-difference signal is used by the control to direct a dc drive motor and operate the feed motion. Machine is capable of providing repeat cuts to accuracies of 0.002 in at production rates as high as 300 in/min carriage feed and 30 in/min head feed.

Education News of the Month

The **AEC** recently created about 150 special fellowships carrying stipends of $1800 each plus extra allowances for postgraduate studies in physical sciences and nuclear engineering.

Electronic Engineering Representatives (EER), an affiliation of independent field engineers and manufacturers' representatives announced creation of a $2000 annual scholarship for students of electrical engineering, specializing in electronics. EER comprises Burlingame Associates Ltd., Gawler-Knoop Co., G. Curtis Engel & Assocs., RMC Assocs., and I. E. Robinson Co.

Sperry Gyroscope Co. held a meeting with leading educators of New York City and State to acquaint them with industry's educational requirements, with the aim of revising high school study courses in this direction.

Dr. Lisle L. Wheeler (center) instructs William Fenninger, chief of technical and vocational education, N. Y. State Ed. Dept., while Philip Becker, N.Y.C. asst. superintendent of schools looks on.

Said Dr. L. L. Wheeler, Sperry's chief engineer: "Last year, alone, perhaps as many as 100,000 high school seniors in the nation did not enter college because of lack of interest, and many who did enter had deficiencies in various vital technical subjects."

The **National Science Foundation** has announced new fellowships for 1957/58 for research in natural sciences by three programs: predoctoral—for college seniors; postdoctoral; and senior postdoctoral—five years after attaining the doctor's degree. Stipends range from $1600 to $10,000 per year according to qualifications. Approximately 1000 awards will be made. Closing dates are January 7, 1957; December 24, 1956; and January 14, 1957 in the same sequence as above.

A conference on Undergraduate Mathematics Curriculum was held in October at **Hunter College,** New York,

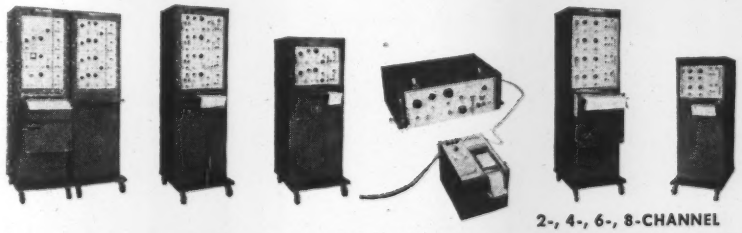
SIGHTS of rockets swooshing heavenward become more and more familiar as we thumb through today's industrial publications. The recalcitrant rocket shown on this page indicates that things *can* go wrong in research, and we don't claim that the absence of a Sanborn oscillographic recording system somewhere along the line was the reason for this disappointing trajectory.

What we do wish to say is that Sanborn equipment is playing an increasingly vital part in rocket development. Used in the laboratory to record flight behavior simulated by analog computers, and in plotting rooms at testing bases to tape down telemetered data, Sanborn "150's" are helping rockets to get and stay where they belong.

You can see Sanborn systems in many other places, too. Oil fields, electronic component production lines, machine tool plants, hydraulic testing laboratories, numerous aircraft manufacturers, computing facilities . . . are putting single to 8-channel Sanborn systems to work. (Most are housed in vertical mobile cabinets, while those in the "field" are often divided into portable packages for each instrument.) All of them give their users inkless, permanent recordings in true rectangular coordinates, one percent linearity, as many as nine chart speeds, and the efficiency (and economy) inherent in Sanborn unitized design. A dozen different plug-in preamps further extend their value, by making changeover to new recording inputs a quick and easy procedure.

SANBORN COMPANY

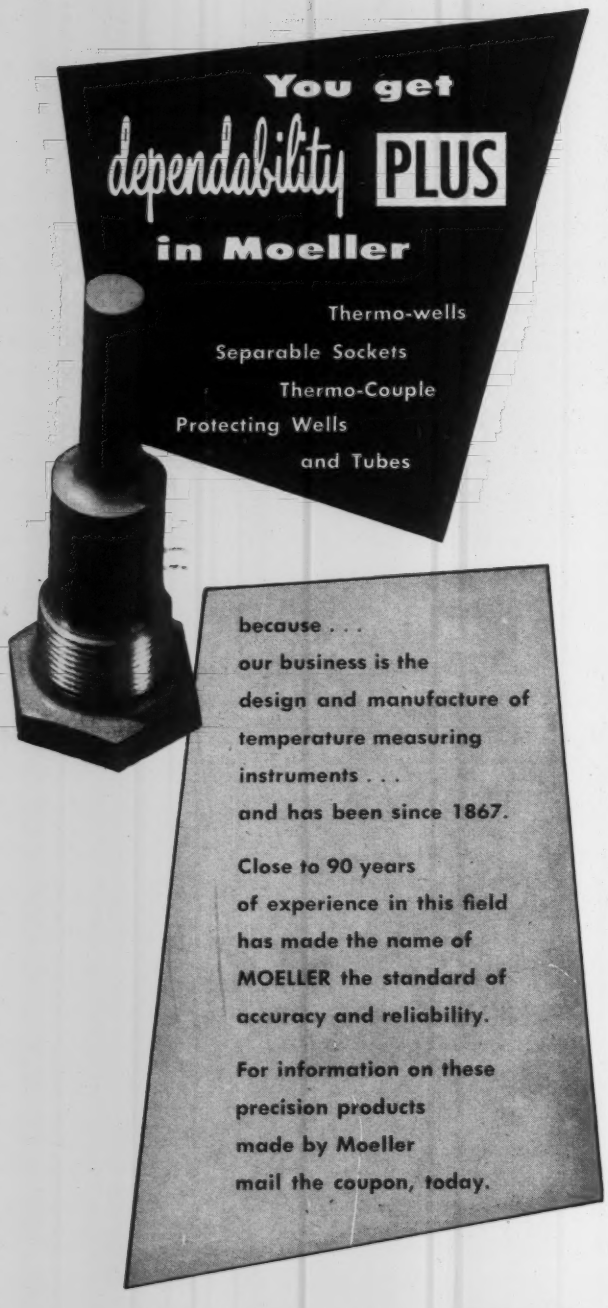
CAMBRIDGE 39, MASSACHUSETTS



8-, 6-CHANNEL 4-CHANNEL 2-CHANNEL 1-CHANNEL 2-, 4-, 6-, 8-CHANNEL ANALOG COMPUTER SYSTEMS

Which way rockets are going may not be a primary concern of yours. But if recording problems *are*, you're apt to find some interesting and useful answers in Sanborn's 16 page "150 System" catalog. Write to us for a copy.

For more information circle **20** on inquiry card.



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NEWS —CONTINUED

"to strengthen and improve the teaching of mathematics in undergraduate schools." The National Science Foundation was its sponsor.

A committee of consultants has been working with the Pittsburgh Public School System in planning a 3-year curriculum in instrumentation and electronics at the high-school level. Although primary object is to train technicians, it is planned as a full pre-academic course designed to give the graduate a sound background in science while preparing him in the skills of an instrument technician. Milton Aronson, editor of *Instruments and Automation*, is chairman of the Advisory Committee to the Pittsburgh schools. Local chapters of the ISA, IRE and the AIEE are cooperating in this unique venture. Orville Orbum is chairman of an ISA committee, appointed to assist in this program.

At **Cooper Union's** recent centenary celebration, Lewis L. Strauss, chairman of the AEC discussed our present sad state of available scientists and engineers. Apart from the larger requirements of a rapidly expanding economy, the low birth rate in the thirties accounted for a deficiency of about one million college-age students compared with the early forties. Statistics show that (1) students taking plane geometry dropped to 12% from 31% at the beginning of the century; (2) only 8 out of 100 high school students now study chemistry; only 4% study physics; (3) about ¼ of all high schools in the United States offer their students neither physics nor chemistry; (4) of the upper-20% students in all classes fewer than half go to college, and only one-third of them remain and graduate. (5) In a recent survey conducted by Purdue University among 15,000 high school students, nuclear science was at the very bottom of the preferred careers—with storekeeper, clerk and mechanic leading—because 45% of the students assessed their own high school training as too poor!

As a plausible remedy Mr. Strauss proposed to stiffen college entrance requirements to include a minimum of credits in the sciences and mathematics for *all* students in whatever courses. Thereby local school boards will be compelled to provide adequate instruction in these fields to ensure their high school graduates in their communities of admission to college, and local taxation will have to provide funds to pay proper salaries to get qualified teachers.

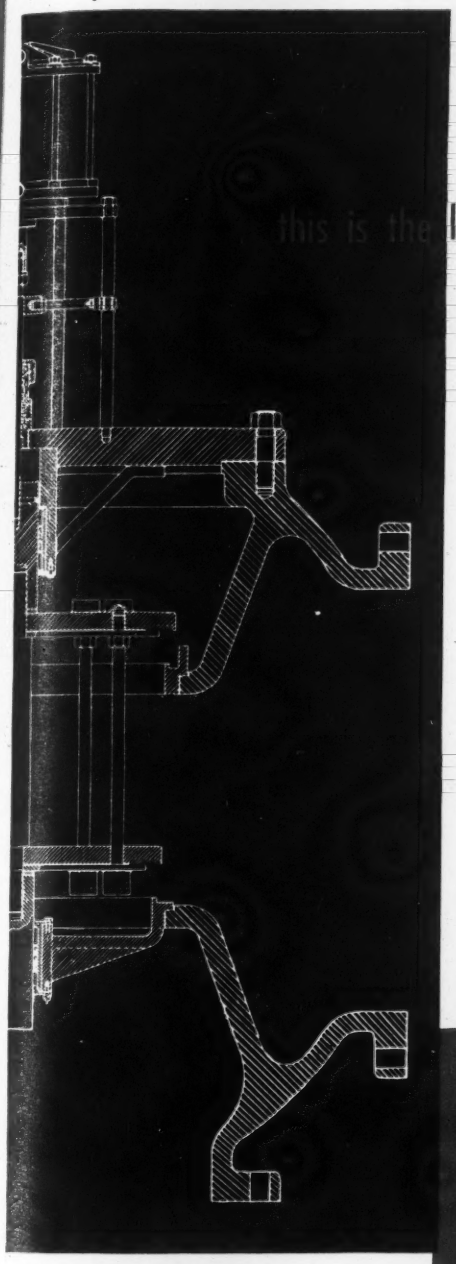
News Bits

FISCHER & PORTER CO. has been presented with President Eisenhower's Award of Merit for outstanding services in conjunction with National Hire the Handicapped Week.

UNDERWOOD CORP. has unveiled the Elecom 125, a new medium-scale electronic computer designed expressly for business data processing applications. Also new "Dataflo" system produces continuous chain of business communications as a byproduct of any original typewritten record. Plug-in units expand the system to solve various applications.

LEEDS & NORTHRUP CO. will engineer and construct the complete control system for the 1000 kw Curtiss-Wright Corp. research reactor to be used for research and development projects in the nuclear field.

BECKMAN INSTRUMENTS, INC., announces its Scientific Instruments Div. has begun development of a



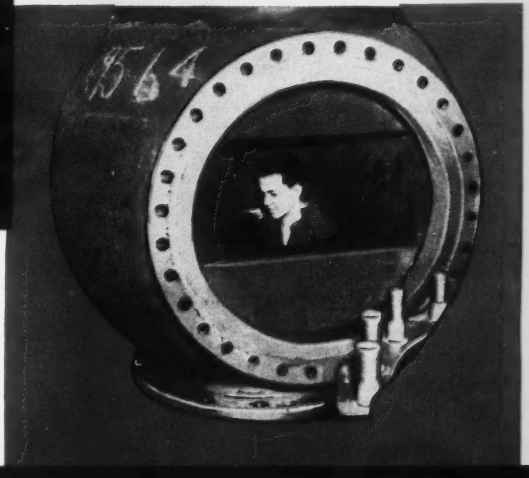
this is the largest double-seated control valve ever made

When you are talking *big* control valves, talk to Kieley & Mueller. K&M is the largest manufacturer of the big ones, control valves above 16 inches. Standard globe-type valves are available in 20, 24, 30 and 36 inch sizes; even larger valves will be produced on special order.

This 36-inch double-seated angle valve closes snugly on giant Teflon seats. The inner valve positions responsively, gliding on special roller-slide bearings. It's massive, but is operates protected by a K&M patented torque resistor. Beyond the problem of size, this valve is mounted on its side, and it has been performing creditably for over four years.

BIG or small, if it's control valves, you'll like the pitch-in, helpful approach of your local K&M representative . . . plus capable engineering and manufacturing follow-thru at the K&M plant.

Write for Bulletin CV-53.



ABOVE: Partial cross-section of K&M 36-inch valve showing general construction.

AT RIGHT: Actual size of a 36 inch valve can be visualized from this illustration of a workman inside the valve body performing finishing operations.

K&M

KIELEY & MUELLER, INC.

64 Genung Street • Middletown, New York

78th Anniversary . . . Oldest U.S. Pressure and Level Control Valve Manufacturer

For more information circle **22** on inquiry card.

NOW! LOW COST
MODULATING CONTROL
FOR TEMPERATURES UP TO 600° F

ANOTHER NEW IDEA FROM **FULTON SYLPHON**

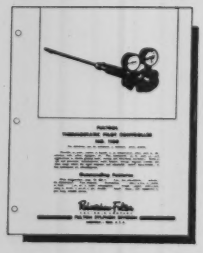
New FULTROL Thermostatic Pilot Controller No. 1100-C & D

Here is another example of how Fulton Sylphon gives you the best temperature control for your process at the lowest possible cost. This time it's an all-new FULTROL Thermostatic Pilot Controller—a simple, compact unit that now enables you to control temperatures up to 600° F. with *proportional* accuracy, but at *on-off* cost.

All that FULTROL needs is an air or other supply at a constant pressure anywhere between 18 and 40 psi. From then on, FULTROL strait-jackets temperature by modulating the output pressure to a final control valve, damper, or other device. FULTROL does all this by means of a simple, stainless steel thermal element. There are absolutely no troublesome pivots or levers.

What's more, you get all these extra features in the bargain:

- Instant knob adjustment of control setting over any 200° range specified between —50° F. and 600° F.
- Easily adjustable proportional band from 5° to 25° F.
- Protection against over-run temperatures (100° above range limit)
- Resistance to pressures up to 300 psi.



SEND TODAY FOR CATALOG SHEET NO. 10-28XL

Mr. Controls

Robertshaw-Fulton CONTROLS COMPANY

FULTON SYLPHON DIVISION • Knoxville 1, Tenn.

TEMPERATURE REGULATOR HEADQUARTERS U S A

For more information circle **23** on inquiry card.

NEWS —CONTINUED

high-speed electronic data processing system capable of recording up to 5,000 pieces of test information in a single second. Designed to record split-second changes in temperature, pressure and other physical variables, the 200-channel system will enable Westinghouse Gas Turbine Div. engineers to chart jet engine performance on magnetic tape for study by an IBM 704 computer.

STROMBERG-CARLSON'S new Model 100 can record data from modern electronic computers many times faster than previously used methods. Seven-in-dia Charactron shaped beam tube takes ⅔ sec to fill its screen with 6,500 characters—a 300-page book can be recorded in 30 sec. Same company has also recently equipped Strong Memorial Hospital with the "silent" Pagemaster system of signalling members of the staff. Coded signals operate one pocket-size receiver carried by doctor.

RADIO MOSCOW'S claim that the Soviet "Atom-Powered" clock will lose or gain only one second in 300 years, and thus is the "World's most accurate" appears to be incorrect—the National Company's "Atomichron", now commercially available, will lose or gain one second in 3,000 years. The Standard Electronics Research Corporation's "Maser," disclosed at Third Automation Exposition, is said to be even more accurate.

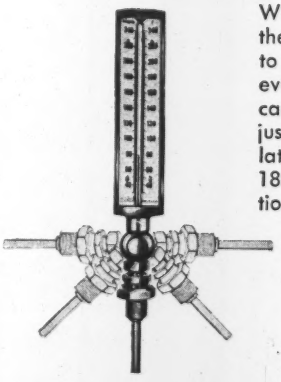
ATOMIC ENERGY COMMISSION has issued a license for export of a research reactor to Japan.

JEWELED-TIP pens are incorporated into a line of strip chart recording instruments made by Minneapolis-Honeywell's Industrial Division. The minute, clear, syn-

with

WEKSLER INSTRUMENTS

ADJUST-ANGLE THERMOMETERS

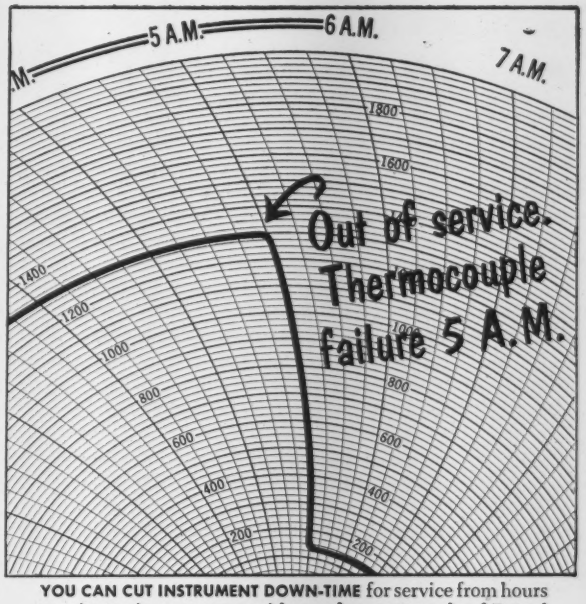


Weksler ADJUST-ANGLE thermometers are designed to offer greater visibility at every angle. The moveable case and stem, can be adjusted before or after installation to any position within 180°. Ideal for most applications . . . for any industry.

Call your local jobber for the Weksler AA-56 Bulletin giving full details or write direct.

WEKSLER THERMOMETER CORP.
195 East Merrick Road • Freeport, L. I., N. Y.

For more information circle **120** on inquiry card.



YOU CAN CUT INSTRUMENT DOWN-TIME for service from hours to minutes in most cases with an adequate supply of Bristol thermocouples and pyrometer accessories.

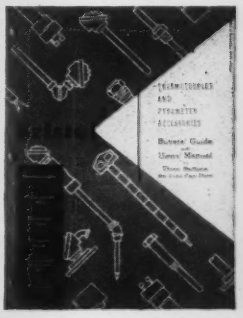
How much can interrupted pyrometer service cost you?

Now's the time to worry—before it happens—about what interrupted pyrometer service can do to your production schedules, cost figures, and quality controls.

And now's the time to lay in a supply of Bristol's pyrometer supplies and accessories to cut down-time to a minimum. Bristol's complete line of thermocouples, protection tubes, radiation-unit accessories, refractory insulators, mounting fixtures, thermocouple wire, and extension wire, switches, ink, and charts, are available in a wide selection of interchangeable sizes and types to fit all standard installations.

They're backed by Bristol's 51 years experience in industrial pyrometry. We've built thousands of pyrometers for every application—in iron, steel, non-ferrous metal smelting and refining; in petroleum, chemical, ceramics, glass, paper, and food-processing industries and in power, heat and incineration utilities.

You'll find these pyrometer supplies completely described in our 56-page Bulletin P1238, together with technical data on selection, installation, maintenance, and calibration. Write for your copy today. The Bristol Company, 154 Bristol Rd., Waterbury 20, Conn.



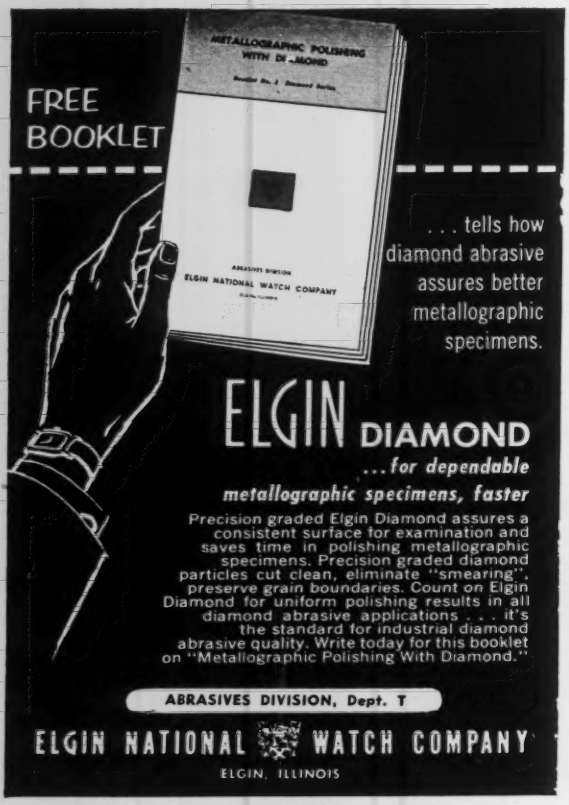
FREE BULLETIN P1238. Tells how to select, install, calibrate and care for thermocouples and pyrometer accessories.

BRISTOL *Points the Way in Human-Engineered Instrumentation*

6.18

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **24** on inquiry card.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METALLOGRAPHIC POLISHING WITH DI-MOND
ELGIN NATIONAL WATCH COMPANY
. . . tells how diamond abrasive assures better metallographic specimens.
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Precision graded Elgin Diamond assures a consistent surface for examination and saves time in polishing metallographic specimens. Precision graded diamond particles cut clean, eliminate "smearing", preserve grain boundaries. Count on Elgin Diamond for uniform polishing results in all diamond abrasive applications . . . it's the standard for industrial diamond abrasive quality. Write today for this booklet on "Metallographic Polishing With Diamond."
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ELGIN NATIONAL WATCH COMPANY
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For more information circle **25** on inquiry card.

ROBBINS

RAF DEHYDRATION

HI-LO FLOWS—HI-LO PRESSURES

- New Leak Proof Design—Chambers and Cartridges.
- No gas bypassing Cartridge.
- "O" Ring Seal of Chambers and Cartridges.
- Mechanical Filter Elements easily removed for cleaning.
- No tools required to change cartridge or element.
- Automatic units for continuous and/or intermittent drying.
- For Portable, stationary and airborne installations.

Write for Bulletins

ROBBINS AVIATION

1735 W. Florence Ave., Los Angeles 47, Cal.

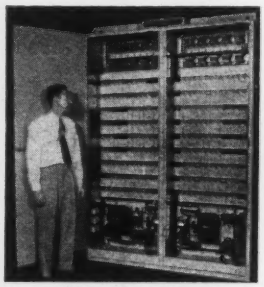
For more information circle **26** on inquiry card.

NEWS —CONTINUED

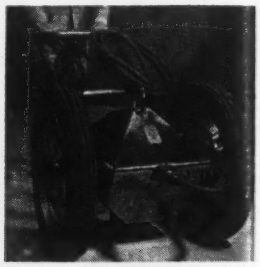
thetic, sapphire pen points are said to provide smoother operation with unlimited life expectancy.

WESTINGHOUSE ELECTRIC has delivered an economic dispatch computer to West Penn Electric Corp. that will compute its dispatch of 1440 megawatt peak load over a 29,000 sq m area.

STATIC SWITCHING has been installed by General Electric on a four-stand tandem cold mill of the Youngstown Sheet and Tube Co. at their Indiana Harbor plant. The new transistor switch can establish and interrupt circuit continuity while retaining circuit isolation from switching unit power supply. .



Static Switching



Multitron

MULTITRON, said to be the most powerful isotope radiography machine ever developed for portable field work, has been delivered to the Newport News Shipbuilding and Drydock Co. by the Nuclear Systems Div. of The Budd Co.

DAYSTROM INC. will build equipment for the Curtiss-Wright open-pool type research reactor at Quehanna, Pa.

CLARY CORP. announces development of electronic devices for subjecting adding machines to short tests which represent the equivalent of five years actual office operation.

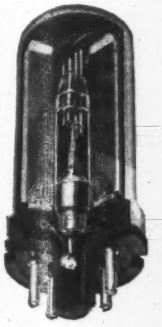
RADIO PROPAGATION ENGINEERING DIV. of the NBS Boulder Labs. has been reorganized to facilitate increased research grown out of tropospheric scatter propagation, radio noise, modulation, and navigation techniques. Projects include basic radio, phase stability, modulation studies, tropospheric and terrain effects on propagation and design of an airborne microwave refractometer.

BATTERY-LESS FLASHLIGHT makes it possible to read a map in total darkness. Using a non-hazardous radioisotope, the new flashlight has been manufactured by New England Nuclear Corp. with a variety of light outputs and colors—can be made in any size and shape.

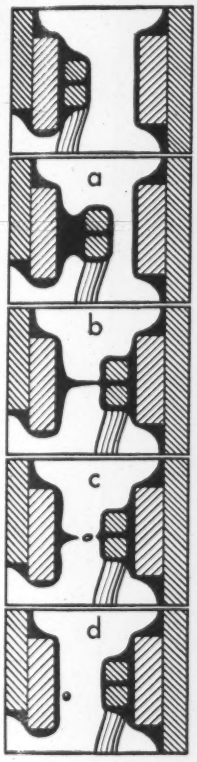
AEROJET-GENERAL NUCLEONICS announces that the start up of the first mass-produced, training and research reactor, the AGN 201, has been accomplished. Reactor went critical with 656 grams of Uranium-235 in the form of 20% enriched uranium oxide. This new reactor concept is the first to be conceived, designed, constructed and started-up with private venture capital.

SHEFFIELD CORP. has developed a new pneumatic-to-electric transducer that responds in a few milliseconds and makes possible faster gaging and control for automated machines, planes and missiles.

LEVIN INSTRUMENT LATHES, with spherical turning rests, are being used by Solex Labs. to produce the



OF OPERATIONS WITH **NO CONTACT WEAR OR BOUNCE**

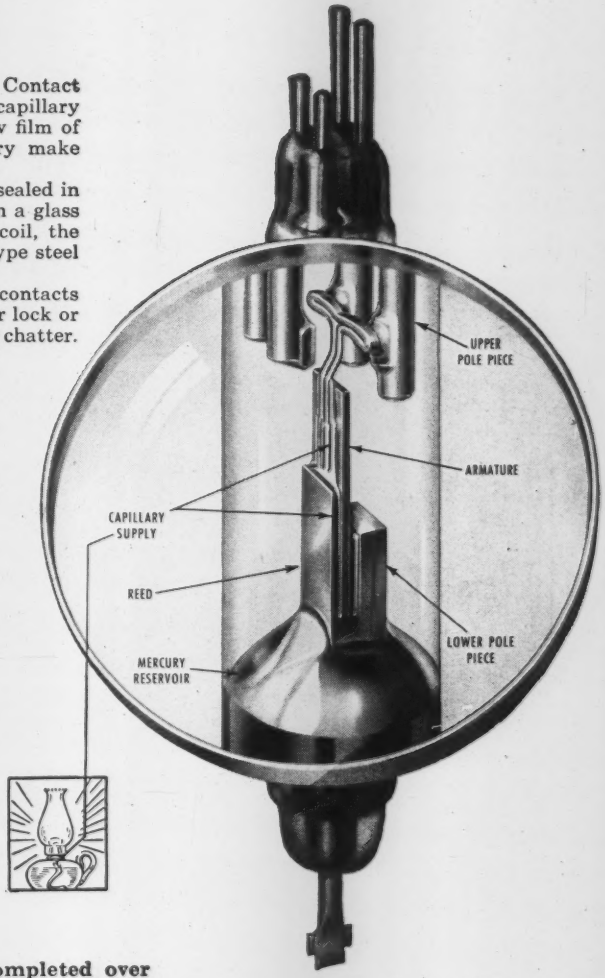


Contacts of CLARE Mercury-Wetted Contact Relays are constantly renewed. By capillary action, like that of a lamp wick, a new film of mercury coats each contact with every make and break.

The magnetic switch is hermetically sealed in a high-pressure hydrogen atmosphere in a glass capsule. Surrounded by the operating coil, the capsule is enclosed in a vacuum-tube-type steel envelope.

Unlike ordinary relay contacts, these contacts never wear down; never get dirty; never lock or weld; never get out of adjustment; never chatter.

Drawings (left) from stroboscopic photographs, show the cycle: (a) Filament of mercury forms between the contacts as they separate. (b) This becomes narrower in cross section and (c) finally parts at two points, allowing a globule of mercury to fall out. (d) The momentary bridging of the parting contacts—and the extremely fast break which ends it—minimizes the arc and adds greatly to contact load capacity. Contact closure between the two liquid surfaces bridges any mechanical chatter and prevents any chatter from appearing in the electrical circuit.



Relays on continuous test have completed over 3,000,000,000 operations with a contact load of 5 amperes at 50 volts—and are still going strong.

Send for Clare Engineering Bulletins Nos. 120 and 122. Address: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare & Co., 659 Bayview Ave., Toronto 17. Cable Address: CLARELAY.

CLARE RELAYS

FIRST in the industrial field

For more information circle 37 on inquiry card.

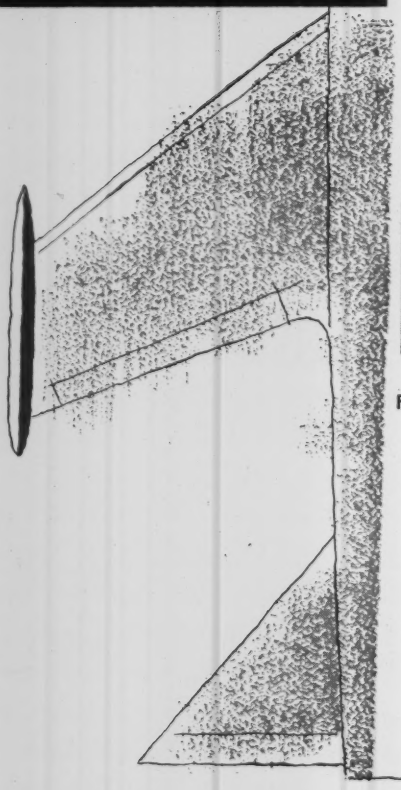
First
by performance test

DataTape Flight Recorder

If you want *accurate* reproduction under the most adverse test conditions, get acquainted with Consolidated's DataTape Recorder. Compact and versatile, DataTape gives you a combination of quality advantages found in no other airborne recorder.

One of many unique features is DataTape's precision and integral capstan assembly which operates under highly adverse environmental conditions with a minimum of flutter. All critical components of the tape drive system are located on a separate plate assembly to minimize vibration and warpage. A filtered capstan drive mechanism isolates the tape drive from any disturbance in the drive motor assembly. And the Recorder is provided with 9½" stiffened tape reels as further precaution against vibration.

In recent Air Force competition tests, the DATATAPE FLIGHT RECORDER topped all others on the basis of over-all evaluation!



For complete information including detail photographs, write today for your copy of Bulletin CEC 1561-X22.

FIRST CHOICE FOR FLIGHT-TEST DATA RECORDING

DATA CHANNELS... 12 or 24 standard, plus 1 flutter-control track and 1 time or voice track per 12 data channels.

TAPE SPEEDS... 7½, 10, 15, 20, 30, and 40 in/sec.

RECORDING TIME... 43 minutes at 10 in/sec; 57 minutes at 7½ in/sec.

FLUTTER... less than 0.15% peak-to-peak (0.08% rms) over 0-to-300-cps band @ 10 in/sec. At 30 in/sec, flutter from 0-to-300 cps will be less than 0.1%. Servo flutter compensation on playback reduces this figure still further; electronic system compensates for flutter at higher frequencies.

POWER... 115 volts, single-phase, 50/60/400 cps; 275 watts.

SIZE... 7 x 22 x 11¾"; 60 pounds.

CONTROLS, INDICATORS... all on top plate. Warning lamps indicate data loss from mechanical or electronic failure.

Consolidated Electrodynamics

CEC

300 North Sierra Madre Villa, Pasadena, California

NATIONWIDE COMPANY-OWNED SALES & SERVICE OFFICES

For more information circle **28** on inquiry card.

thinner, more comfortable Tuohy Corneal Lens (contact lens). Finished lens averages twenty-hundredths of a millimeter in thickness and weighs less than one-fiftieth of a gram.

GENERAL ELECTRIC radio coordination units for traffic control will be installed along a 2½ mile section of the Middlesex-Fells Parkway in the Boston area.

Financial Bits

SQUARE D CO. states annual sales will reach the $100 million mark for the first time in 1956.

WALWORTH CO. announces net income for first nine months over $3 million, 127% above same period in 1955.

LITTON INDUSTRIES announces one-year, after-tax earnings to July 31 over $1 million, 130% increase over previous year.

SNYDER TOOL AND ENGINEERING CO. announces fiscal year sales to June 30 of over $9 million.

ASSOCIATED SPRING CORP. announces nine-months' sales of $39 million, with net earnings after taxes over $2 million.

KAY LAB announces profit of $150,515 through first three quarters of 1956.

THOMPSON PRODUCTS, INC., and subsidiaries, announces net sales for first nine months over $214 million.

PARKER APPLIANCE CO. earned net profit of $335,706 on sales of over $5 million in three-month period to Sept. 30.

NUCLEAR-CHICAGO announces net sales passed $2 million mark for first time in year ending August 31.

CLEVITE CORP. reports third quarter earnings over $1 million.

DAYSTROM, INC., reports net profits of $589,000 in its second quarter, ended Sept. 30.

SYLVANIA reports net sales for first nine months of 1956 over $232 million.

HOFFMAN ELECTRONICS CORP. announces sales for first nine months of 1956 over $34 million.

Stock Report

The following prices and price ranges are supplied by Bache & Co., 36 Wall Street, New York 5, New York.

Oct. 31, 1956

OVER-THE-COUNTER	Bid	Asked
Aerovox corp.	4 1/4	5 1/4
Aircraft Radio Corp.	16 3/4	18 1/4
Argus Corp.	19	19 7/8
Barry Controls Inc. "B"	8 3/4	10
Bittel-McCullough Co.	36	37 1/2
Electronic Associates, Inc.	56	60
Elox Corp. of Michigan "A" (d)	9 1/4	10
Elox Corp. of Michigan "B" (d)	9 1/2	10 1/8
Erie Resistor Corp.	18 1/2	20
G. M. Giannini (a)	39	41
I-T-E Circuit Breaker	31 1/4	33 1/2
Liquidometer Corp.	11	12
P. R. Mallory & Co., Inc.	39	41
W. L. Maxson Corp.	6 1/4	7 1/4
Penn Controls, Inc.	21	21 3/4
Speer Carbon Co.	29 1/4	31 1/4
Sprague Electric Co.	34	36
Taylor Instrument Co.	62	64
Telecomputing Corp. (a)	5	5 1/2
Topp Industries, Inc.	8 3/8	8 3/4
Varian Associates	17 1/4	17 5/8
Vitro Corp. of America (a)	20 3/4	22

Continued on page 2366

A Superior Detector
for
Infra-Red Spectroscopy

GOLAY PNEUMATIC DETECTOR

Among the characteristics that render the Golay Detector superior to other types of detectors for use in infrared spectroscopy are:

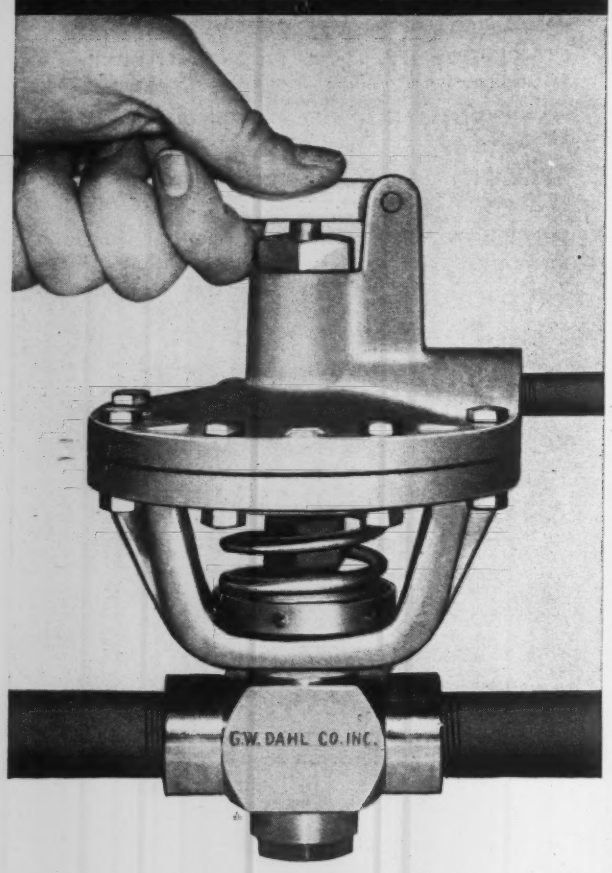
1. **An effective sensitive area 3/32" in diameter.**
2. **Sensitivity of 6 x 10^{-11} watts RMSENI when used with "chopped beam" method and with recording time constant of 1.6 second.**
3. **Uniform sensitivity from the ultra-violet through the visible and the entire infra-red, and up to the micro-wave region.**
4. **Improved, drift-free, A.C. operated amplifier with step gain controls and four response periods.**

Write for EPLAB Bulletin No. 10

THE EPPLEY LABORATORY, INC.
SCIENTIFIC INSTRUMENTS
2 SHEFFIELD AVENUE, NEWPORT, RHODE ISLAND, U.S.A.

For more information circle **29** on inquiry card.

"MANUAL RESET"



A "BLOCK-SAFE" VALVE

Wherever control or supply air to pneumatically operated instruments and valves operating on dangerous or toxic process flows, or the process flow itself, must be blocked for safety, "manual reset" valves will provide safe, vigilant guarding of lives and property.

They will snapact at a predetermined falling control pressure to either vent diaphragm air or lock it at the desired pressure.

Upon return of control air they must be manually reset. Nothing is left to chance.

Available in various materials in sizes up to 1" IPS.

For prices, further technical information, and our representative's address in your area, inquire directly to our home office.

George W. DAHL Company

BRISTOL, RHODE ISLAND

For more information circle **30** on inquiry card.

NEWS —CONTINUED

New York Stock Exchange:

Security	Price Range for 1956 Thru Oct. 31 High	Low	As of Oct. 31
ACF Industries	67 7/8	55	57
Aeroquip Corp.	17	11 7/8	16 5/8
Allis Chalmers	37 1/4	31 1/4	31 3/8
American Chain & Cable	58 1/2	38 1/2	55 1/2
American Machine & Foundry	36 3/8	24 1/8	35
American Machine & Metals	45 1/4	35 1/8	43 1/4
American Optical	40 3/4	33 1/2	34 1/8
American Tel. & Tel.	187 1/8	165	166 1/4
Argus Camera	27 1/2	20 1/2	22 1/4
Beckman Instruments	38 1/2	25 1/8	37
Bell & Howell	47	28 1/4	41 1/2
Bendix Aviation	63	48 1/2	57 3/8
Boeing Airplane	59 1/8	45 3/8	54 3/4
Bullard	38 3/8	28 1/2	29
Bulova Watch	23	20 1/4	20 1/2 - 20 5/8 (.)
Burroughs	46 7/8	28 1/2	40 1/8
Cartorundum	45 1/8	31 1/2	40
Cincinnati Milling Machine	55 1/4	37 1/4	48 1/2
Clevite	24 1/4	18	19 1/4
Columbia Broadcasting "A"	32 7/8	22 5/8	27 1/2
Consolidated Electronics	36 1/2	26 1/2	37 1/4
Cornell Dubilier	40 1/8	25	27 3/8
Corning Glass	87 1/2	64	67 1/4
Curtiss-Wright	41	26 3/4	40
Cutler Hammer	61 1/4	53	57 1/4
Daystrom	27 3/8	22	26 1/4
Dobeckmun	39 1/4	28 3/4	29
Douglas Aircraft	95 5/8	72 1/2	87
Eastman Kodak	100 3/4	77 3/4	90
Eaton Manufacturing	66	51 1/2	63 1/2
Electric Auto Lite	41 3/8	33 1/8	35 1/2
Elgin Watch	17 3/8	12	12 3/8
Food Machinery & Chemical	77	52	63 3/4
Gamewell	32 3/8	25 5/8	28
Garrett	53 1/2	38	49 1/2
General Dynamics	79 1/4	56 5/8	72 1/4
General Electric	65 1/2	52 3/4	59 3/4
General Instrument	10 1/8	7	7 1/8
General Mills	71 3/4	61	68 3/8
General Precision Equipment	53 1/2	34 1/2	37
General Railway Signal (Old)	95 1/2	61 1/2	87 1/4 - 89 1/4 ( )
General Railway Signal (New)	31	29 1/4	29 1/2
General Telephone	46	38	41
General Time	34 5/8	29 1/2	32 - 33 (1)
Goodyear	81 1/2	60	77 5/8
Hamilton Watch	27	19	25
Hoffman Electronics	25 3/8	20 1/2	20 7/8
International Business Mach.	523	400	467
International Tel. & Tel.	37 3/8	29 1/4	31 1/2
Lockheed Aircraft	54 1/4	43 1/4	52 5/8
Magnavox	41	32 3/8	32 3/8
Minneapolis Honeywell	90 1/2	58	77 3/4
Minnesota Mining & Mfg.	75 1/2	61 1/8	64 1/2
Motorola	51 3/4	40 1/8	42 3/4
National Acme	82	62	74
National Cash Register	59	34 1/8	51
North American Aviation	49 7/8	39 5/8	42 7/8
Northrop	29 1/8	21 1/4	23 3/8
Otis Elevator	50 3/4	33 1/4	42 3/4
Philco	36 1/2	18 1/2	18 3/4
Radio Corp. of America	50 3/8	36 1/2	36 1/2
Raytheon	19 1/2	13	15 1/4
Rheem Manufacturing	37 1/8	18	18 3/4
Robertshaw Fulton	28 3/8	21 1/2	23
Sangamo Electric	37 1/2	29 1/2	32
Sperry Rand	29 1/8	22 1/4	23 1/2
Square D	28 5/8	22 5/8	27 1/4
Standard Coil	12 3/4	7 5/8	7 5/8
L. S. Starrett	58 1/2	43 3/4	51 - 53 1/2 (1)
Stewart-Warner	39 1/2	30 1/4	35 1/4
Sylvania Electric	55 7/8	42	47 1/2
TelAutograph	15 1/4	8 1/2	8 3/4
Texas Instruments	17	11 5/8	15 1/2
Thompson Products	77 1/2	48 3/8	76 1/2
Tung-Sol Electric	36 3/8	27	30 1/4
Underwood Corp.	44	21 5/8	22
Union Carbide & Carbon	133 3/8	103 1/4	112 3/4
Western Union	22 1/2	18 1/4	18 1/2
Westinghouse Air Brake	36 3/8	29	29 7/8
Westinghouse Electric	68 7/8	51 1/2	52
Worthington Corp.	59 1/2	41 1/8	56
General Tire	66 3/4	50	51 1/2

(1) Bid - Asked price; no sale.

American Stock Exchange:

	Price Range for 1956 Thru Oct. 31 High	Low	As of Oct. 31 Last
Air Associates	13 1/2	9	10 1/8 - 10 1/2 (I)
Arc Equipment	24	18	18
American Meter	41	32 1/2	32 1/4 - 33 1/4 (I)
BeLock Instrument	19 3/8	13 1/4	13 1/4 - 14 (I)
Benrus Watch	10 3/8	7 3/4	7 7/8 - 8 (I)
Breeze Corp.	9 1/8	6	6
Clark Controller	37	16 1/4	32
Clarostat Mfg.	5	3 5/8	3 1/2 - 3 3/4 (I)
Clary Corp.	6 7/8	4 5/8	4 3/4
Consolidated Electrodynamics	32 1/2	22	30
Du Mont Labs	10	5 5/8	5 3/4
Dynamics Corp. of America	8 3/8	5 3/4	5 3/4
Electronics Corp. of America	24 1/4	9 7/8	9 7/8
El-Tronics	9 7/8	3 1/2	3 1/2
Fairchild Camera & Inst.	25 7/8	19 1/2	20 3/4
Globe-Union	22	17	18
Hazeltine Corp.	48	33 1/2	33 1/2
International Resistance	8 1/4	5 1/8	5 1/8
Lear Inc.	10 1/4	7 3/8	8
Litton Industries Inc. (A)	29	23	28
National Research Corp.	29 3/4	17 7/8	19 1/2
Neptune Meter	36	28 3/8	30 1/2
New Haven Clock	2 1/2	1 1/2	1 1/2
Norden-Ketay	14 7/8	7 5/8	9 1/8
Nuclear Corp. of America "A"	2 1/2	3/4	7/8
Pneumatic Scale	28 1/4	21	25 5/8 - 26 3/4 (I)
Reliance Electric	58 1/2	38 7/8	49 - 51 (I)
Servo Corp. of America	7 3/4	5 1/8	5 7/8
Servomechanisms	11 7/8	8 1/4	11 3/4
United Shoe Machinery	61 5/8	46	43 3/4
Wallace & Tiernan	27 5/8	19 1/2	26 1/4
Waltham Watch	3	1 1/4	1 3/4

(I) Bid - Asked price - no sale.

absorb

SHOCK

like a stack of cushions

Components must be *more* than tough to stand up under the punishment to which ground support equipment is subjected. That's why WESTON Ruggedized instruments are favorites for applications when severe shock and vibration are encountered . . . as well as for mobile equipment requiring instruments that will continue functioning—*accurately*—through shock, vibration, moisture, or temperature extremes. AVAILABLE IN ALL REQUIRED SIZES, IN A-C, D-C, RF AND THERMO TYPES. For the complete story on Weston Ruggedized instruments, or on other instruments for panel, laboratory, production or servicing needs, consult your nearest Weston representative, or write Weston Electrical Instrument Corp., Newark 5, N. J.

WESTON

Ruggedized

PANEL INSTRUMENTS

A DAYSTROM UNIT

For more information circle **31** on inquiry card.

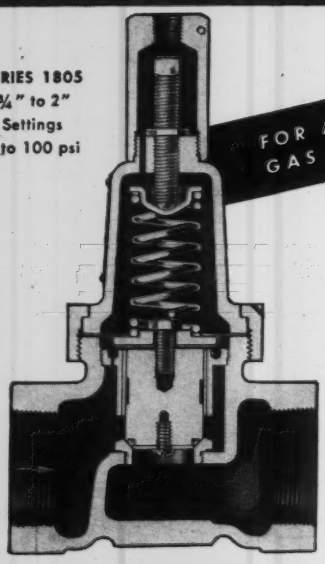
look to FISHER

for genuine relief from overpressure worries!

Hundreds of plants have found Fisher compact and self-contained relief valves the answer to their relief or back pressure control problems. Whether it may be a rather unusual problem, or simply to protect your gas system for safety reasons, or possibly to relieve excess pressure from a pump, by-passing back to suction, the chances are Fisher could solve your problem. May we suggest you contact our representative in your area?

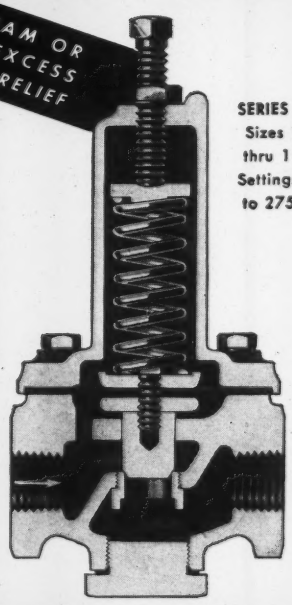
SERIES 1805
¾" to 2"
Settings
5 to 100 psi

FOR AIR OR GAS RELIEF



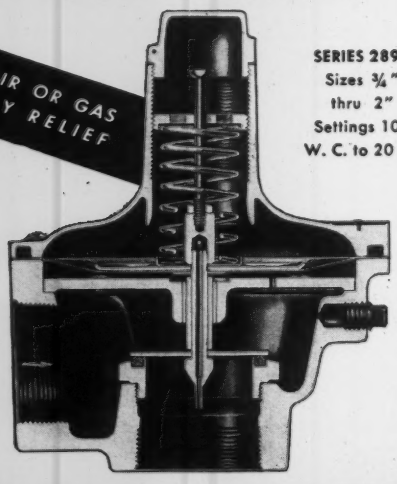
FOR STEAM OR LIQUID EXCESS PRESSURE RELIEF

SERIES 372
Sizes ½"
thru 1½"
Settings 10
to 275 psi



FOR AIR OR GAS SAFETY RELIEF

SERIES 289H
Sizes ¾"
thru 2"
Settings 10"
W. C. to 20 psi



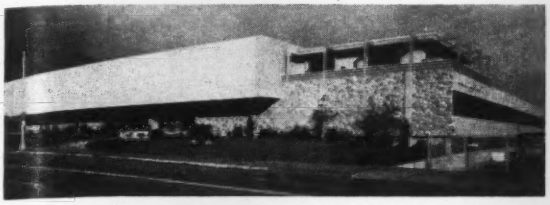
FISHER GOVERNOR COMPANY
MARSHALLTOWN, IOWA • WOODSTOCK, ONTARIO
LEADS THE INDUSTRY IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL

FISHER
Since 1880

For more information circle 32 on inquiry card.

New Plants and Mergers

CONSOLIDATED ELECTRODYNAMICS CORPORATION'S new engineering, research, and marketing center



has three stories with a total floor space of 130,000 square feet. Cost was $1.5-million.

ELECTRONIC ENGINEERING CO. announced groundbreaking Oct. 22 for their new lab and general offices at 1601 E. Chestnut St., Santa Ana, Calif.

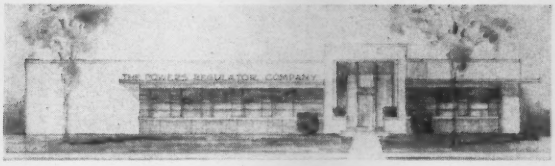
MINNEAPOLIS-HONEYWELL—VALVE DIV. announces a $1½ million manufacturing plant and home office will be constructed at Fort Washington, Pa.

WALTHAM WATCH CO. Joseph Axler, president, announces an enlarged development program in aircraft instrumentation by new management team.

GE—COMPUTER DEPT. announces plans for its headquarters in Phoenix, Ariz.

STRATOS DIV., FAIRCHILD, announces purchase of the "Governaire" line of regulators from the Bellofram Corp., and 7500 sq ft addition for the Industrial Products factory.

E&S OPTICAL, INC., are in their new building at Oak Ridge Road, Oak Ridge, N. J.



POWERS REGULATOR CO. is beginning construction of a new office-warehouse at 6645 N. Ridge Ave., Chicago.

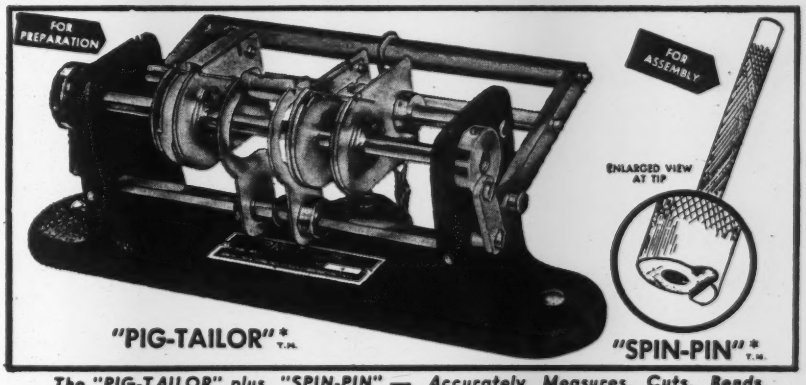
WESTON announces new district sales offices; 2001 S. Grand Ave., Los Angeles; 7613 Reading Road, Cincinnati, Ohio; 101 N. 33 St., Phila., Pa.; Caldwell Ave. and Rt. 22, Union, N. J.

VARIAN ASSOCIATES held an open house at their Palo Alto plant October 14 that featured an "electronic groundbreaking" for their $2 million microwave tube factory.

R. S. WILDER INC. Waltham, Mass., announces appointment of Opto-Metric Tools, Inc., as national and foreign distributors for micro-projectors, optical comparators and micrometer measuring stages.

"PIG-TAILORING"

. . . . a revolutionary new mechanical process for higher production at lower costs. Fastest PREPARATION and ASSEMBLY of Resistors, Capacitors, Diodes and all other axial lead components for TERMINAL BOARDS, PRINTED CIRCUITS and MINIATURIZED ASSEMBLIES.



The "PIG-TAILOR" plus "SPIN-PIN" — Accurately Measures, Cuts, Bends, Ejects and Assembles both leads simultaneously to individual lengths and shapes — 3 minute set-up — No accessories — Foot operated — 1 hour training time.

PIG-TAILORING provides:		PIG-TAILORING eliminates:	
1. Uniform component position.	6. Individual cut and bend lengths.	1. Diagonal cutters.	6. Broken leads.
2. Uniform marking exposure.	7. Better time/rate analysis.	2. Long-nose pliers.	7. Short circuits from clippings.
3. Miniaturization spacing control.	8. Closer cost control.	3. Operator judgment.	8. 65% chassis handling.
4. "S" leads for terminals.	9. Invaluable labor saving.	4. 90% operator training time.	9. Excessive lead tautness.
5. "U" leads for printed circuits	10. Immediate cost recovery.	5. Broken components.	10. Haphazard assembly methods.

* PATENT PENDING

Write for illustrated, descriptive text on "PIG-TAILORING" to Dept. IA-12P

BRUNO-NEW YORK INDUSTRIES CORPORATION

DESIGNERS AND MANUFACTURERS OF ELECTRONIC EQUIPMENT

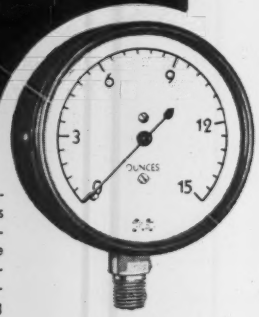
460 WEST 34th STREET • NEW YORK 1, N. Y.

For more information circle **33** on inquiry card.

MARSHALLTOWN

DIAPHRAGM GAUGE

For Accurate Pressure Measurement in Ounces or Inches of Water



Marshalltown Figure 83 is an extremely sensitive gauge that uses a carefully seasoned bronze diaphragm to accurately measure very low pressures. It is used extensively on many types of natural gas installations for checking low pressures.

Write for details and price. LOOK TO MARSHALLTOWN FOR ONE OF THE MOST COMPLETE LINES OF INDICATING PRESSURE GAUGES MADE!

Available in standard dials (reading in inches of water) 0-15" -0-30" -0-60" -0-100" -0-160" . . . also in ounce graduated dials from 15 ounces to 5 pounds. 2½", 3½" and 4½" dial sizes mounted in black enameled steel case.

MARSHALLTOWN MANUFACTURING CO.

MARSHALLTOWN 3, IOWA

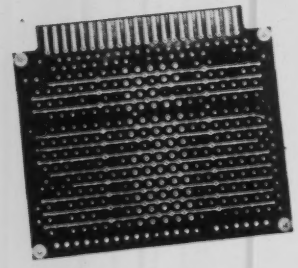
For more information circle **34** on inquiry card.

TRACER-GUIDED DRILLING

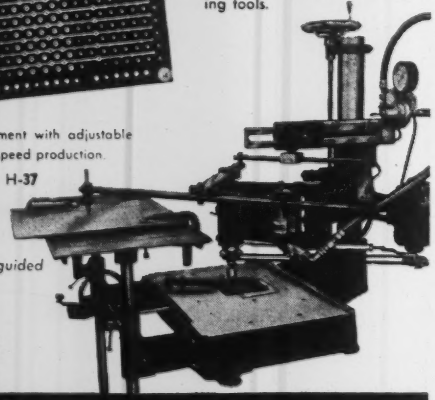
100 HOLES P. M.

WITH NEW HERMES Engravograph

for printed circuit plates



- Pantograph reproduces drill pattern from template in any reduction ratio — assuring high accuracy.
- Allows drilling and routing of different size holes in one operation without changing tools.



Pneumatic attachment with adjustable feed gives high speed production.

Ask for catalog **H-37**

Also for tracer-guided

ENGRAVING
PROFILING
GRADUATING

new hermes ENGRAVING MACHINE CORP.
13-17 University Place, New York 3, N.Y.

PLANTS—CONTINUED

SUPERIOR TUBE CO.'s new plant and office building nearing completion will more than triple present floor space.

LEDEEN, INC., announces a new plant at Gilman Road and Garvey Blvd., El Monte, Calif.

BAIRD ASSOCIATES-ATOMIC INSTRUMENT CO announces net profits over $170,000 on sales of over $2 million for nine months ending June 30, 1956, and including one month of merged operations.

DAYSTROM PACIFIC CORP., Santa Monica, Calif., announces ground-breaking in late Sept. for its new office-research-manufacturing structure in Westchester.

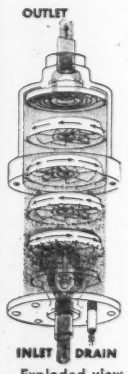
KEITHLEY INSTRUMENTS, INC., Cleveland, Ohio, now occupies new facilities providing five times former plant space.

SIERRA ELECTRONIC CORP. announces plans for immediate construction of a new plant in Menlo Park, Calif.

INSTRUMENT DEVELOPMENT LABS., INC., have moved their main office and factory to Attleboro, Mass.

ARIDIFIER CLEANS GAS AND AIR LINES—TRAPS OIL, WATER, DIRT

92% OF IMPURITIES are trapped by the unique ARIDIFIER action shown at right and removed from the air or gas line *before* damage is done to sprayers, air hoists, tools, etc. Compressed air powering upward through the ARIDIFIER spins the four multi-bladed aluminum rotors in alternately opposite directions. Water, oil and dirt in the air stream are caught by the whirling blades and hurled by centrifugal force to the vertical walls. Downward gravity flow then drains this sludge into a trap. Self-cleaning, the ARIDIFIER needs no maintenance other than periodically purging the drain trap. Ten models have 7 CFM to 17,000 CFM capacities. Catalog sent on request by Logan Engineering Co., 4921 West Lawrence Ave., Chicago 30, Ill.



Exploded view showing ARIDIFIER operation. Capacities, 7 to 17,000 C.F.M.

For more information circle **35** on inquiry card.

1957 1958 1959 1960 1961

DEPENDABILITY

Guaranteed for 5 years

The best guarantee in the business!

The 401 is so dependable, we're backing it with a *five year guarantee* on all printed wiring and power transformers . . and, all other components, including the cathode-ray tube, carry a full one-year guarantee.

DU MONT 401

- **IDENTICAL X- AND Y- AMPLIFIERS:** Sensitivity, 10 mv/cm. Sinewave response extends flat from dc to 150 kc. Calibration standards built-in for both amplifiers.
- **SWEEPS:** 18 calibrated ranges extending from 50 ms/cm to 4 us/cm. 3 times sweep expansion available.
- **RELATIVE PHASE SHIFT BETWEEN AMPLIFIERS:** Easily set for less than 1° at frequencies below 150 kc.
- **CATHODE-RAY TUBE:** Tight tolerance Type 5ADP-, operated at 3000 volts acceleration.
- **STABLE OPERATION:** Regulation of all power supply potentials, including heaters, provides complete stability.

Best buy in the medium price range—a general-purpose, low-frequency oscillograph for complete, high-quality quantitative measurement. The 401 offers a new high in precision, ease of operation and convenience as a result of "human engineering"—an exclusive of the Du Mont 400 philosophy of instrument design.

WRITE FOR DETAILS.

$420.00
(slightly higher for 50-cycle areas)

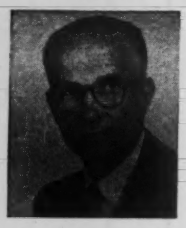
DU MONT® *One of the 400 Series*

TECHNICAL SALES DEPARTMENT, ALLEN B. DU MONT LABORATORIES, INC. • CLIFTON, N. J.

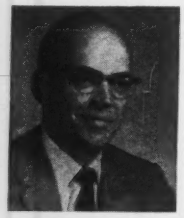
For more information circle **36** on inquiry card.

People IN THE NEWS

DR. WILLIAM SHOCKLEY, Director of the Shockley Semiconductor Laboratory of Beckman Instruments, Inc., and *Dr. Walter Brattain* and *Prof. John Bardeen* have been awarded the 1956 Nobel Prize for Physics for their development of the transistor.



W. Shockley
Beckman



Orval Riggs
Thermco

THERMCO LABS. announces appointment of *Orval Riggs* as general manager in charge of all commercial activities.

MINNEAPOLIS-HONEYWELL REGULATOR CO. announces appointment of *Edwin B. Olson* as manager, market planning.

MASON-NEILAN DIV., WORTHINGTON CORP., announces *Carl W. Gram, Jr.,* has been named vice president in charge of sales.

BAIRD ASSOCS.—ATOMIC INSTR. CO. announces appointments of *Wilburt M. Draisin* as promotions manager and *Arthur L. Krasnow* as assistant sales manager.

Peter T. Reuter

Peter T. Reuter, manager of the Boston district office of Bailey Meter Co., died October 5, at the age of 58. He is survived by his wife and three daughters.

POTTER AERONAUTICAL CORP. *David M. Potter,* president, has been awarded life membership by the Explorers Club.

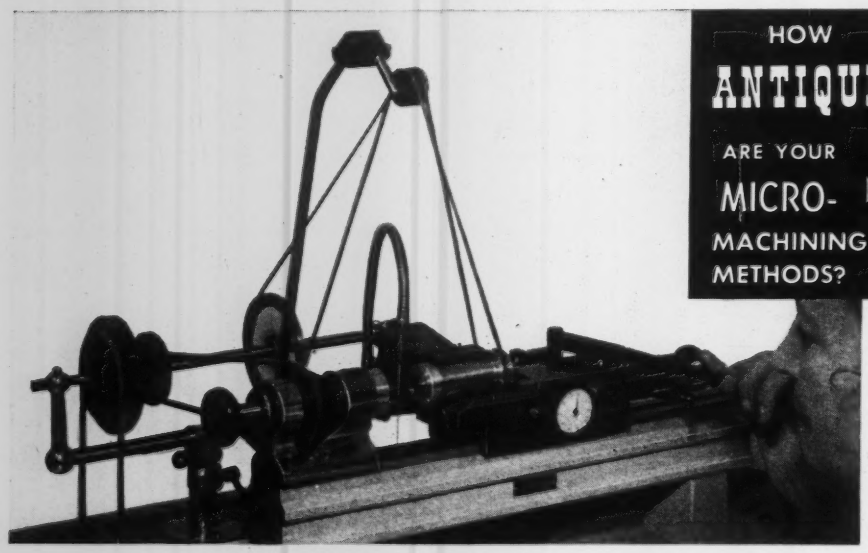
D. M. Potter
Potter

A. I. Thompson
Barton

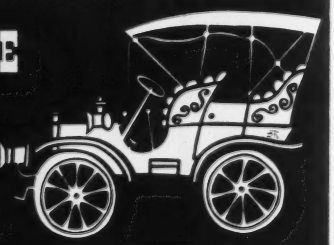
BARTON INSTRUMENT CORP. announces appointment of *A. I. Thompson* as vice president in charge of sales.

UNDERWOOD CORP. announces appointment of *Fred M. Farwell* as chief executive officer.

STROMBERG-CARLSON announces appointments of *Robert A. Burt* as manager of the systems analysis section, and *Bernard Elbinger* as manager of the special products section of Electronic Control Systems, Inc., an affiliate.



HOW ANTIQUE ARE YOUR MICRO-MACHINING METHODS?



DRILL MICRO-HOLES

DOWN TO .0016" with SPEED & ACCURACY

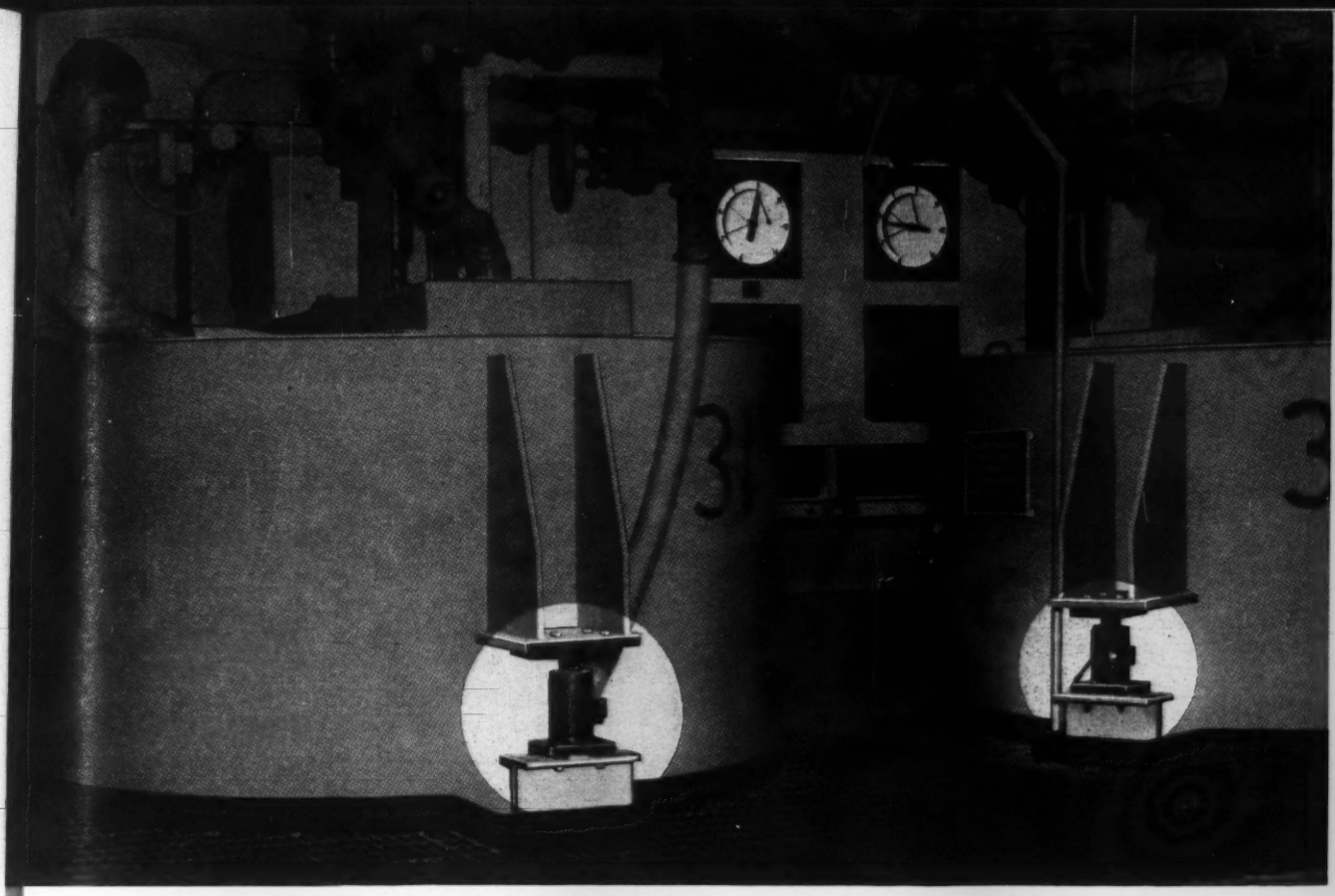
ON LEVIN® INSTRUMENT LATHES

The Levin micro-drilling equipment shown here can be used with the smallest drills available. It is designed so that the drilling does not depend on the operator's sense of feel. The drill can be retracted for chip removal and returned to the drilling position without striking the bottom of the hole. While commercial drills can be had as small as .0016" this micro-drilling apparatus has successfully produced holes as small as .0006".

Send for Catalog M describing complete line of instrument lathes and accessories.

LOUIS LEVIN & SON, INC.—3610 S. BROADWAY—LOS ANGELES 7, CALIFORNIA

For more information circle **37** on inquiry card.



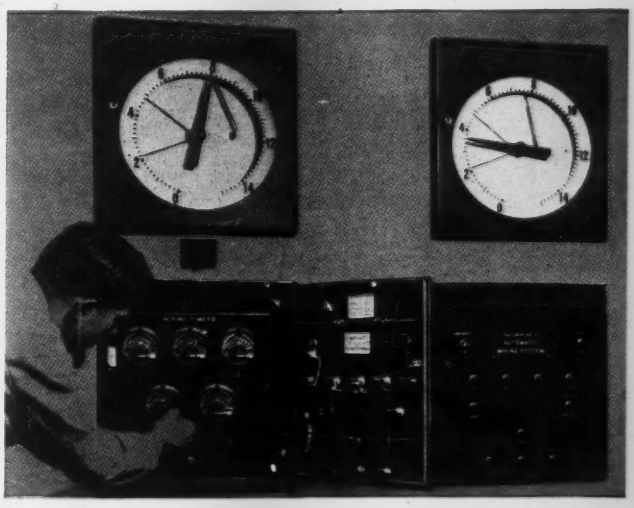
Compact Baldwin SR-4 sealed load cells mount conveniently below tank flanges.

simple, maintenance-free Baldwin SR-4® system proportions 5 ingredients to ±1/10% repeatability

Automatic proportioning of liquid and solid ingredients is achieved in this chemical process by an integrated Baldwin SR-4 system.

Baldwin SR-4 transducers weigh each ingredient as it is added to the batch. The load cells transmit signals to the indicator-controller, automatically opening and closing supply tank valves as required by the formula. This closed loop system is instantaneously responsive and highly accurate.

You can have a Baldwin SR-4 electronic control system, specifically designed for your needs, for any application involving weight, pressure, tension, torque or thrust. We engineer the entire system and calibrate it as a unit, to guarantee you maximum accuracy. For your copy of bulletin 4302, write Dept. 3353, Electronics & Instrumentation Division, Baldwin-Lima-Hamilton Corporation, Waltham, Massachusetts.



Baldwin SR-4 instrumentation for automatic batching includes an indicator-controller-recorder and timer system for each tank.

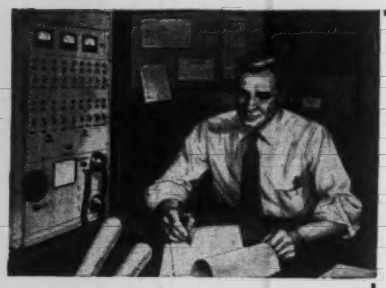
BALDWIN · BLH · LIMA-HAMILTON

ELECTRONICS & INSTRUMENTATION DIVISION
BALDWIN-LIMA-HAMILTON

DIVISIONS: Austin-Western • Eddystone • Hamilton • Lima • Electronics & Instrumentation • Madsen • Loewy-Hydropress • Pelton • Standard Steel Works

For more information circle 38 on inquiry card.

REMOTE CONTROL SYSTEMS

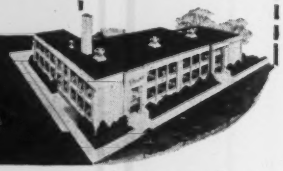


Typical Applications

- SAFETY WARNINGS AND CONTROLS OF ALL KINDS
- WEIGHING, COUNTING, MEASURING TEMPERATURE, ETC.
- MONITORING OF PUMPS, FANS, RESERVOIRS, ETC.
- TO CONTROL CRANES FROM PLANT FLOOR
- BLAST FURNACE WIND SIGNALNG SYSTEM
- AUTOMATIC REMOVAL OF SOAKING PIT COVERS

FOR MODERN INDUSTRY

Femco's remote control systems can guard lives, save time, cut costs and increase production. Get the facts. Submit your problem for a proposal.



Femco Inc.
IRWIN, PENNSYLVANIA
UNderhill 3-3200

Specialists in Electronic Communication and Control.
For more information circle **39** on inquiry card.

ENGINEERS, ME-EE • MATHEMATICIANS

You Don't Need Previous Experience to Get Into

ADVANCED CONTROLS DEVELOPMENT

with General Electric

Whatever professional area you are now in—as long as you have an analytical mind and some scientific experience there is an excellent opportunity for you to enter CONTROLS DEVELOPMENT with the Small Aircraft Engine Department of G.E.

This field is growing in importance every day. Many current requirements are so new that the technical "know-how" must be learned on the job.

The career opportunities are obvious when you consider that every time G.E. creates a more advanced small turboprop, turboshaft or turbojet engine, an entirely new controls system must be developed to take full advantage of the power-plant's potential.

There are reputations to be won in every phase of
CONTROLS ANALYSIS
as well as
CONTROLS SYSTEM and COMPONENT DESIGN

- **RELOCATION EXPENSES PAID**
- **OUTSTANDING BENEFIT PROGRAM**
- **GOOD STARTING SALARY**

Your reply will be handled on a strictly confidential basis.

Write to Mr. T. S. Woerz (Section R-B-1)
Small Aircraft Engine Dept.

GENERAL ELECTRIC

1000 Western Avenue West Lynn, Mass.

PEOPLE—CONTINUED

ASSOCIATED SPRING CORP. announces appointment of *Reginald C. Morrell* as market research manager and *Kent S. Putnam* as advertising manager.

POTTER & BRUMFIELD, INC., announces appointment of *Nelson Havill* as field sales manager.

JOHN CHATILLON & SONS announces appointment of *Sidney E. Aglow* as middle Atlantic area sales representative.

RADIATION COUNTER LABS., Skokie, Ill., announces appointment of *Robert W. Schumann* as chief development engineer.

CONOFLOW CORP. announces appointment of *Albert J. Hanssen* as chief engineer.

BECKMAN INSTRUMENTS, INC., Scientific Instruments Div., announces appointment of *H. S. Stover* as eastern data and control systems representative.

FAIRCHILD CAMERA AND INSTRUMENT CORP. announces election of *James A. Marohn* as vp-Finance.

GENERAL CONTROLS CO. announces appointment of *Morris P. Stillinger* as a sales engineer in Los Angeles.

THOMAS A. EDISON, INC., announces appointment of *John E. Sloane* as manager, special services.

LITTON INDUSTRIES announces appointment of *Dr. Harvard L. Hull* as vice president.

get this

FREE

illustrated bulletin

Learn how easy it is for anyone to read temperatures up to 3000 F. with

ALNOR PORTABLE PYROMETERS

Wherever heat measurement is a problem—in the laboratory, shop, or in the field—you'll find the completely self-contained, portable Alnor Pyrometer the economical answer. Product of skilled, specialized instrument craftsmen, an Alnor will provide the consistent accuracy for all jobs—and at a cost of less than $100.00.

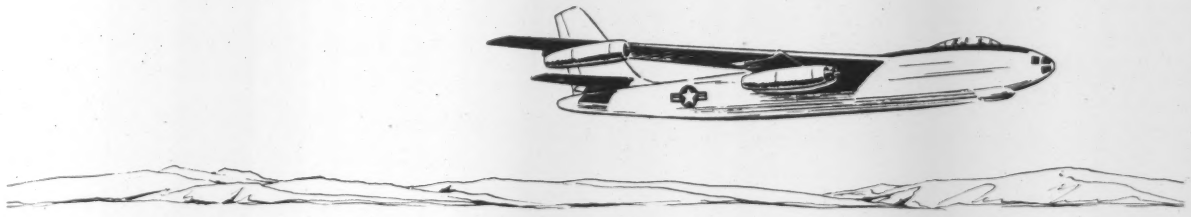
Get your copy of Bulletin 4434 now! Send this ad on your letterhead to: Illinois Testing Laboratories, Inc. Room 518, 420 No. La Salle Street, Chicago 10, Illinois.

Alnor

PRECISION INSTRUMENTS FOR EVERY INDUSTRY

For more information circle **40** on inquiry card.

Air Force selects Consolidated integrated systems



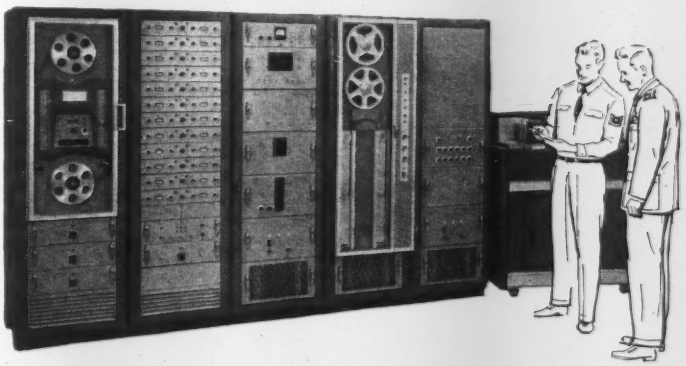
PROBLEM: to accelerate flight testing by getting *all* data processed with greatest possible *speed* and *accuracy*.

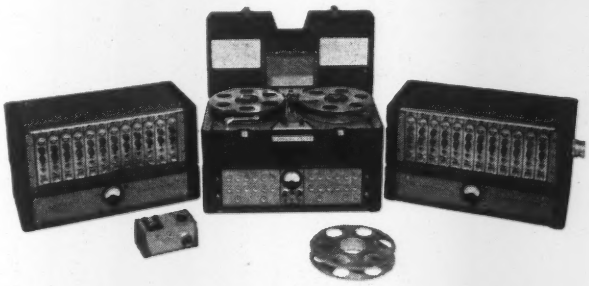
SOLUTION: integrated airborne and ground systems, custom-designed and manufactured by Consolidated's Systems Division.

RESULT: answer in 48 hours instead of 45 days!

Your problem, of course, may be entirely different. Remember that CEC'S Systems Division *custom-engineers* data-processing systems for individual requirements. If you're not sure of what you need, our Systems Engineering will make a recommendation. If you *are* sure, let us work with you. *For more facts on what CEC Systems can do for you, please write for bulletin CEC 1304-X39.*

THE GROUND SYSTEM is the central data-handling facility. Tape is played back and demodulated 12 channels at a time to recreate the analog signals generated in the air. These 12 channels are commutated into the MilliSADIC Data-Processing System at a rate of 400 samples per second (single channel 1500 samples per second), changed into digits, and recorded on digital magnetic tape along with elapsed-time data. The digital tape is played back at a reduced rate into a tape-to-card converter and thence to the IBM punch which generates punched cards at a rate of 75 cards per minute. The digital data processing introduces an error of less than ±.15%. The entire operation reproduces analog signals with a total error of less than 1%.





AIRBORNE SYSTEM records 24 channels of data with a frequency content up to 600 cps. Strain-gage bridge networks, excited by the power-supply units, produce analog signals representing flight-test data, such as pressures, temperatures, fuel flows, strain. DataTape records these data on magnetic tape for playback at the ground station.

Systems Division

Chemical Analysis

Process Monitoring

Dynamic and Static Testing

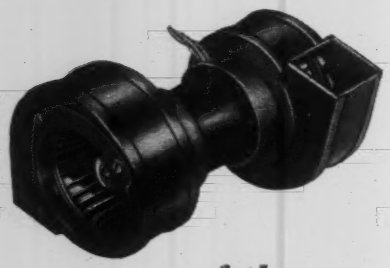
Consolidated Electrodynamics

CEC *300 North Sierra Madre Villa, Pasadena, California*

NATIONWIDE COMPANY-OWNED SALES & SERVICE OFFICES

For more information circle **41** on inquiry card.

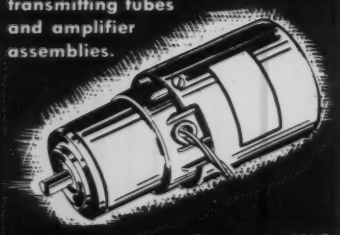
champion...



...of the lightweights

The IMC catalog features a full roster of champions, each a winner in its own right—winner by design engineer's choice on the basis of light weight, compactness and performance.

The IMC line of AC and DC subfractional, servo and gear motors, fans, blowers and dynamotors did not develop by chance. Instead, individual units were evolved and produced in direct response to the design engineer's needs. Now, many of IMC's motor-fan-blower devices are specifically requested for use in cooling of transmitting tubes and amplifier assemblies.



The entire IMC motor line, ranging from 1/1000 to 1/10 hp, presents the broadest possible range of design application. In many of the gear units, actuating devices for control problems can be incorporated on request. IMC has a motor to suit your own particular needs. We look forward to helping you.

Induction Motors Corp.

570 Main St., Westbury, L. I., N. Y.

EDgewood 4-7070

For more information circle 42 on inquiry card.

INSTRUMENTS and AUTOMATION Inquiries

These inquiries, representing problems facing readers of **Instruments & Automation**, are published as a free service to our readers.

Micro Humidity

Professor of biology seeks information on apparatus dealing with micro humidity measurements. A-170

Photoelectric Tubes for Densitometers

Chemist in public works wishes information on use, installation, operation of photoelectric tubes in densitometry. A-171

Ultrasonic Transducers

Engineer in Research Department of University seeks sources of supply for ultrasonic transducers. A-172

European Nuclear Research

European Organization for Nuclear Research seeks suppliers for the following items: Linen based, nylon reeinforced plastic material; nylon (or similar) plates, 5 cm thick; synchros, graduated 3 to 5 in-oz per degree, 10 rps; solenoid valves, 2" or smaller, 220 V, explosion-proof; stainless steel or brass valves; bellows-seal valves, as above; "O"-rings, Buna-N or neoprene; containers for N_2 or H_2 from 10 lit up; meter relays; explosion-proof relays; pressure transducers; wire wound precision pots, rotary, linear; single-point recorders; multipoint recorders (range 10 microamps); analog-to-digital converters; magnetic programming; camera and reels for 35 mm non-perforated film; projector for same; liquid level meters for H_2 and N_2 (liquid); pressure gages 0-150 and 0-200 psig, also 30" vac-150, and 30" vac-200 psig; vacuum gages 0-76 cm Hg; pressure gages as above with adjustable electric contacts; vacuum gages as above with adjustable electric contacts; thermocouples (H_2); thermistors (H_2); gas thermometers for low temperatures; flowmeters for hydrogen gas; fittings for high vacuum, also pressure (20 at) hydrogen-tight; hydrogen liquifiers; air compressors—500 psig, 50 to 200 m^3/hour, with 200 lit tank; hydrogen gas detectors-alarms; rupture discs; flexible tubing for liquefied hydrogen; aneroid membranes for 10-at pressure—all items for erection of bubble chamber. A-173

Identification of Name

Swiss manufacturer would like to know manufacturer of "electronic indicator with trade mark 'Sunbury'." A-174

Information on Coaxial Choppers

Research assistant in electronics laboratory of university desires information on coaxial choppers "relative to both dp-dt models." A-175

Wind Velocity Meter

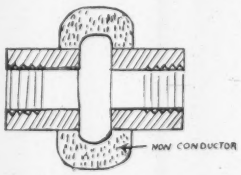
Entomologist at southern University asks for information on Wind velocity meter purportedly of European (Danish?) origin working as a pendulum with a cup attached to catch the wind, a vane for orientation, and a dial for indication. A-176

Liquid SO_2 Integrating Flowmeter

Canadian sugar refinery requires accurate integration of flow through ½" pipe carrying 1200 to 2000 lb of SO_2 under 15 to 20 psig pressure. Indicator and/or recorder, and/or controller, and/or counter, and/or mercurial manometer are acceptable. A-177

Isolating Bushings

Manufacturer of weighing systems and instruments seeks isolating bushing to electrically insulate one section of pipe from another. Seal must be leakproof at 2000 psig (1000 psig acceptable). Large numbers are sought for ⅛" pipe; other sizes desired. A-178



Inclinometers

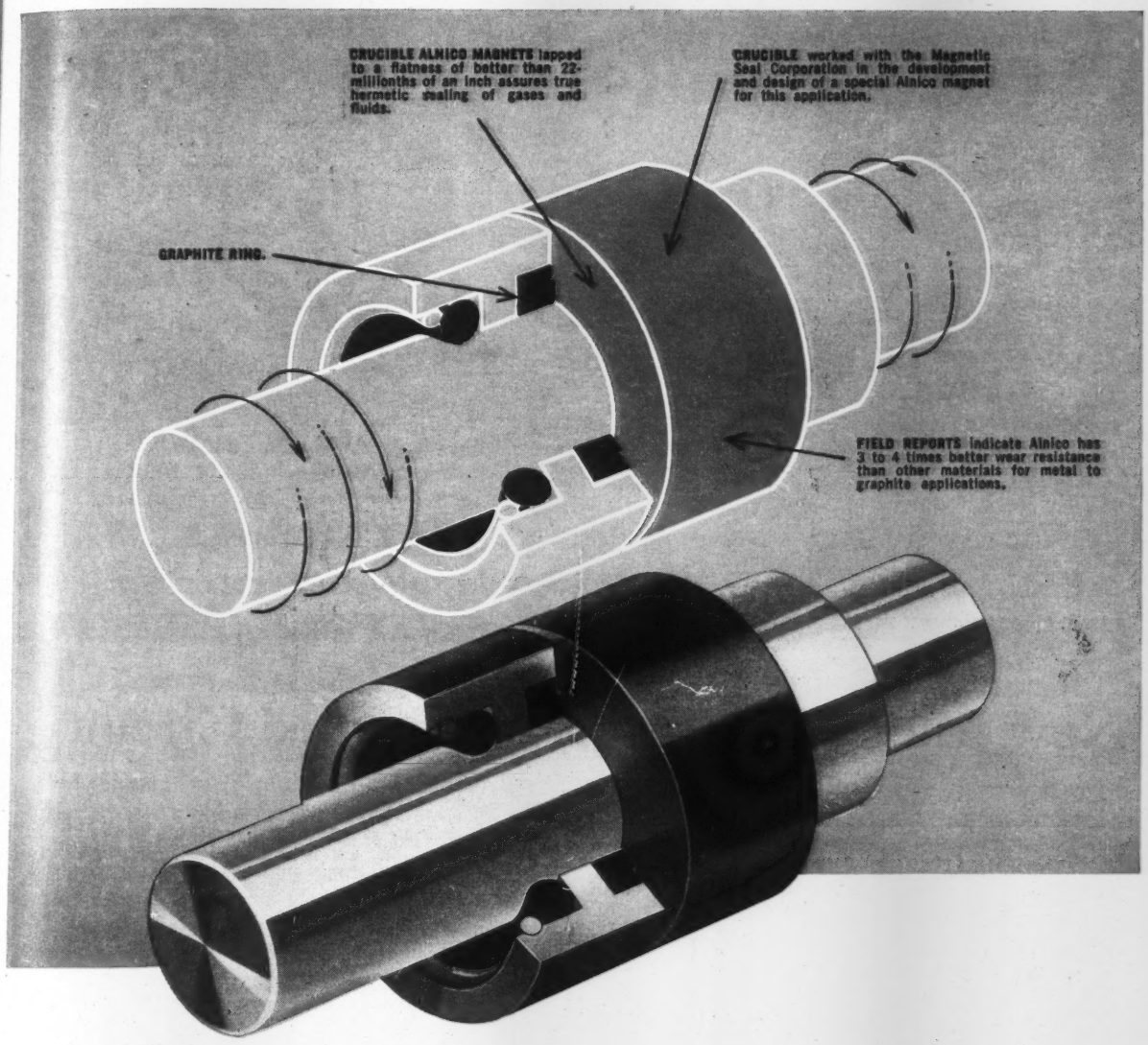
Tool design engineer in aircraft company seeks sources of supply for inclinometers (or a similar adjustable type level of high accuracy) for use in company's tooling section. A-179

Remote Handling Tongs

Mechanical engineer in branch of Government Agricultural Research Service is seeking remote handling tongs for removing material from ⅜"-dia. 5"-long test tubes. A-180

Altimeters

Purchasing agent in mining company wishes to purchase used altimeters "graduated in 1000 feet, marked in 10 foot graduations." A-181


CRUCIBLE ALNICO MAGNETS lapped to a flatness of better than 22-millionths of an inch assures true hermetic sealing of gases and fluids.
CRUCIBLE worked with the Magnetic Seal Corporation in the development and design of a special Alnico magnet for this application.
GRAPHITE RING.
FIELD REPORTS indicate Alnico has 3 to 4 times better wear resistance than other materials for metal to graphite applications.

in magnetic seals, too

CRUCIBLE PERMANENT MAGNETS

mean maximum energy—minimum size

The consistently higher energy product of Crucible Alnico magnets allows smaller parts—greater compactness in special applications like this magnetic shaft seal. What's more, the superior corrosion and wear resistance of Crucible Alnico insures far greater service life.

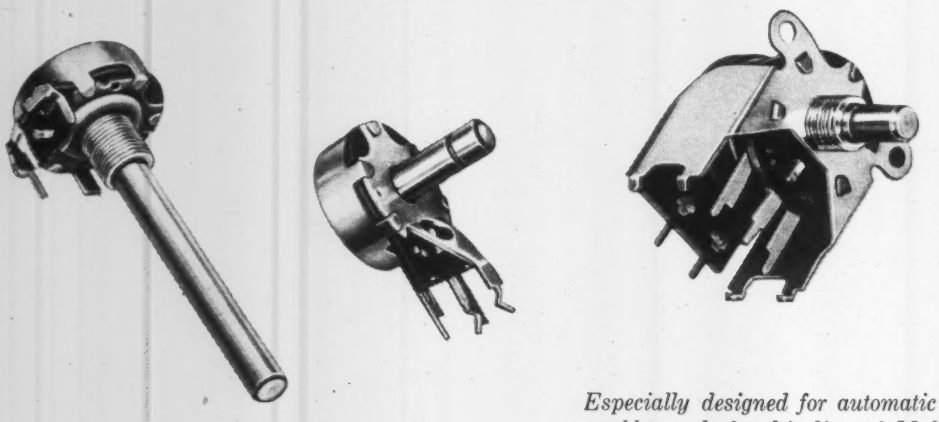
You can regularly get Crucible permanent Alnico magnets sand cast, shell molded, or investment cast to exact size, shape or tolerance requirements . . . and in any size from a mere fraction of an ounce to hundreds of pounds. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

For more information circle **43** on inquiry card.

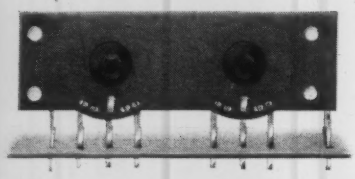
MALLORY



Especially designed for automatic assembly methods, this line of Mallory controls provides superior performance on printed circuit applications.

New Mallory Controls for Printed Circuits

ECONOMICAL STRIP TYPE CONTROLS FOR PRINTED CIRCUIT USE



This simplified series of controls, a Mallory "first", consist of resistance wafers attached directly to a phenolic panel, in single, dual and triple units. You save in installation cost, for multiple units can be mounted as easily as a conventional single. You save in component cost, too . . . for these Mallory controls give you multiple units at substantially lower price than that of a corresponding number of individual controls. Resistance values cover the range from 250 ohms to 10 megohms. Numerous adaptations available. Write to Mallory for technical data.

FOR your printed circuit designs, plan to take advantage of the simplified assembly and extra performance values offered by this new series of Mallory carbon controls.

A variety of designs is available. Included are self-supporting snap-in models for top of panel mounting . . . threaded bushing models . . . and types for mounting directly on the circuit panel. All are built with mounting lugs and terminals, precision-positioned for foolproof, fast assembly by automatic production machines. All incorporate these Mallory features:

High stability resistance element, made by special Mallory process, minimizes drift under severe humidity and temperature variations . . . gives long life.

Unusually low electrical noise.

New "floating ring" line switch, using a unique contact action, can be supplied on the new controls . . . far outlasts ordinary switches, gives clean, sharp make and break.

A complete selection of resistance values and tapers is available to match your circuit requirements. For complete data, write or call Mallory today.

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Tuning Devices • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals • Welding Materials

Parts distributors in all major cities stock Mallory standard components for your convenience.

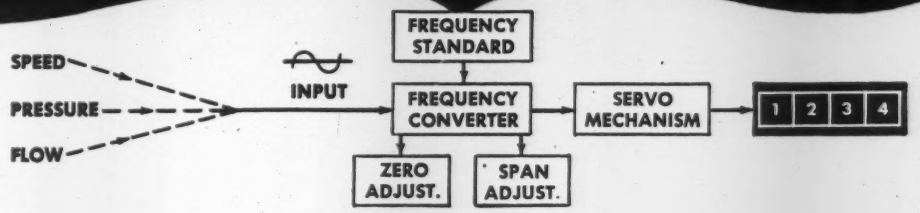
Expect more . . . get more from

P. R. MALLORY & CO. Inc.
MALLORY

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

For more information circle **44** on inquiry card.

Brand New! Analog Type!
COX DIGITAL INDICATOR*



Analog Type Indicator – *Not a Counter*
Instantaneous Digital Readout–RPM, PRESSURE, FLOW
Accuracy to ¼% Thruout Entire Range • Single or Multi-Channel Models • Explosion-proof Housing Optional

The new COX DIGITAL INDICATOR is a digital to analog to digital instrument, having an accuracy heretofore unobtainable in any other indicator of its type. Guaranteed accuracy is ¼% throughout the entire range of the instrument.

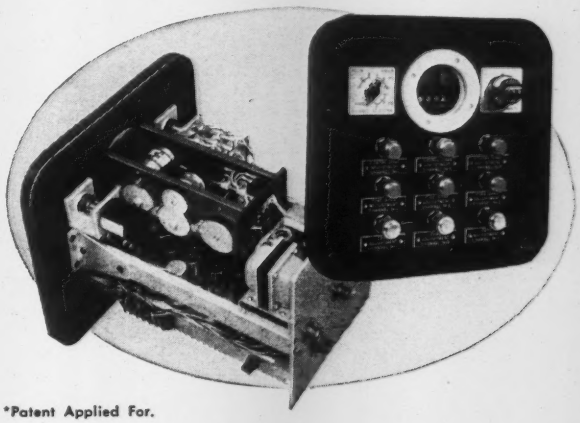
Moreover, when the Cox Digital Indicator is used with a transducer having ½% linearity, the SYSTEM accuracy is *guaranteed* to be ½%—not ¾%—as is normally the case due to the cumulative error of the individual components.

The "matching-error" feature, unique in the Cox Digital Indicator, is made possible through adjustments which permit shifting the indicator curve to parallel the input frequency curve.

Originally developed to be used with the Cox Turbine Flowmeter, the Cox Digital Indicator is ideally suited to all applications where wide range, high accuracy, and instantaneous readout are required. It may be used with any transducer having a variable frequency output.

A built-in frequency standard permits immediate verification of the calibration of the instrument at any time. And the Indicator reads *directly*, without scales or interpolation, in PPH, GPM, PSI, or RPM, etc.

We welcome the opportunity to demonstrate to you the amazing accuracy, compactness and performance of the new Cox Digital Indicator.



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Dear Mr. Hoopes:
I'm interested in full details about an opportunity at General Electric as an Electronic Technician. Please send me more information. I understand all replies are held in strictest confidence.

Mr. Robert H. Hoopes, Personnel Section, A.N.P.D.
General Electric Co., P.O. Box 132
Cincinnati 15, Ohio

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ELECTRONIC TECHNICIAN EXPERIENCE *Check* LIST

Check items listed below indicating approximate months or years of Electronic Technician experience.

	Yrs.	Mos.
☐ High School		
☐ Correspondence School		
☐ Technical School		
☐ Military Service Schools		
☐ College		
☐ Math.-Algebra-Trig. Calculus		
☐ Electrical Drawing		
☐ Radio & TV Servicing		
☐ Testing & Trouble Shoot Electronic Equipment		
☐ Fabricate - Assemble - Wire Electronic Equipment		

	Yrs.	Mos.
☐ Printed Circuit Dev. & Fabrication		
☐ General - Laboratory Development		
☐ Test - Construction		
☐ Nuclear Reactor Controls		
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GENERAL ELECTRIC

P. O. BOX 132 - CINCINNATI 15, OHIO

Events

January 23-25

Symposium on "Theoretical and Experimental Results in the Propagation and Radiation of Very-Low-Frequency Electromagnetic Waves (less than about 100 kc)," NBS Boulder Labs., Boulder, Colo.

January 28-31

Plant Maintenance and Engineering Show, Public Auditorium, Cleveland. For information write Clapp & Poliak, Inc., 341 Madison Ave., New York 17, N. Y.

February 14-15

1957 Transistor and Solid State Circuits Conference, Univ. of Pennsylvania, Phila., Pa. Sponsored by IRE and AIEE.

February 19

13th Annual Quality Control Clinic sponsored by Rochester Society for Quality Control, War Memorial, Rochester, N. Y.

February 26-28

1957 Western Joint Computer Conference, Statler Hotel, Los Angeles, Calif.

March 4-8

Eighth Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, Penn-Sheraton Hotel, Pittsburgh, Pa.

March 5-8

1957 Conference on High-Speed Computers, Louisiana State University, Baton Rouge, La. For information write Frank T. Carroll, Jr., College of Engineering.

March 11-14

The IRE Professional Group on Nuclear Science is cooperating with the EJC Second Annual Nuclear Science and Engineering Congress in Philadelphia. For information write Dr. Sidney Krasik, Editor, IRE—PGNS Transactions, 5621 Wilkins Ave., Pittsburgh 17, Pa.

March 18-21

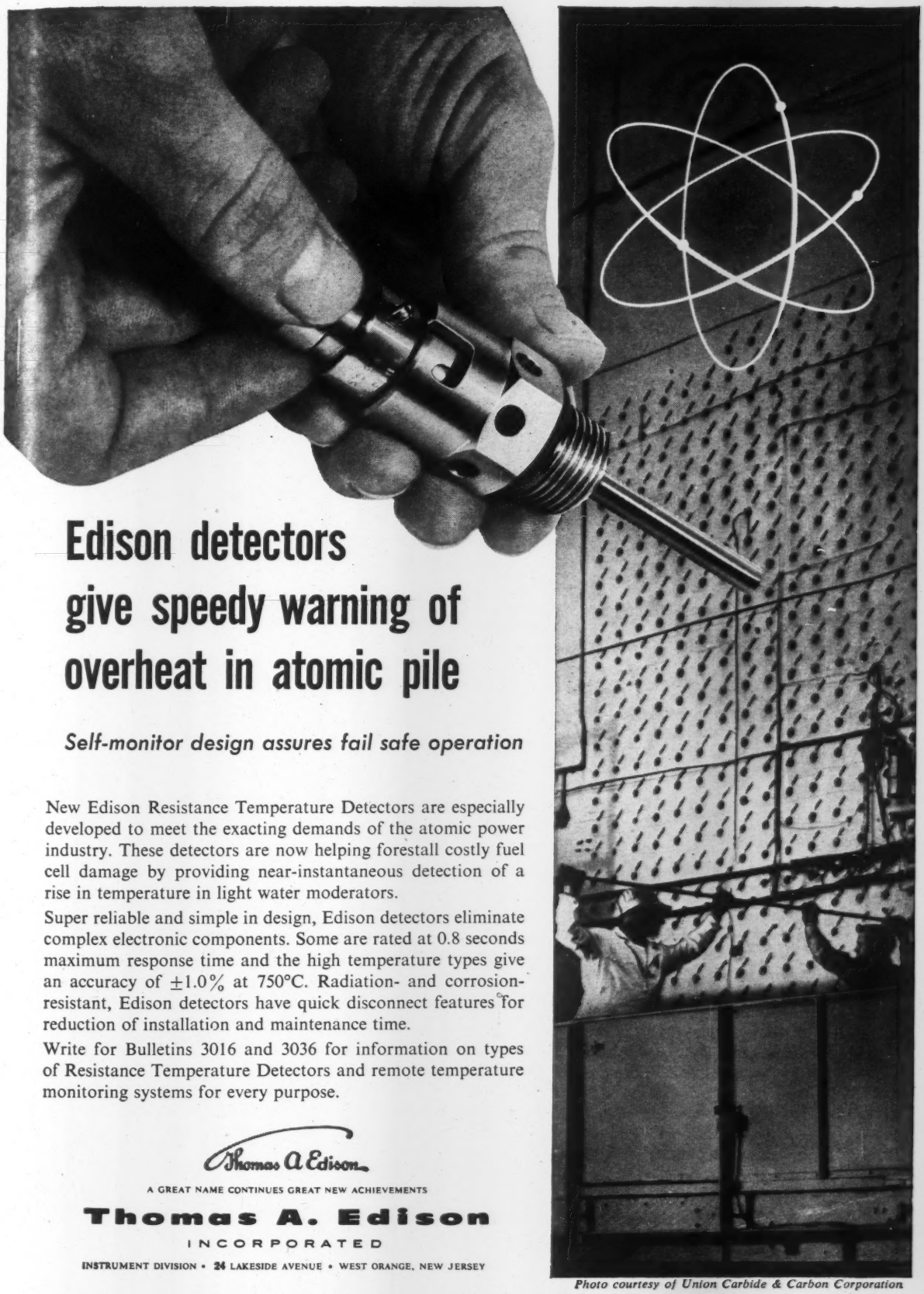
First Military Automation Exposition, New York Trade Show Bldg., 500 8th Ave., New York City, N. Y. For information write Richard Rimbach Associates, 845 Ridge Ave., Pittsburgh 12, Penna.

April 11-13

Ninth Southwestern I.R.E. Conference and Electronics Show, Shamrock Hotel, Houston, Texas.

April 22-24

IRD's 3rd Annual Conference on Control System Applications, Northwestern Univ., Evanston, Ill.



Edison detectors give speedy warning of overheat in atomic pile

Self-monitor design assures fail safe operation

New Edison Resistance Temperature Detectors are especially developed to meet the exacting demands of the atomic power industry. These detectors are now helping forestall costly fuel cell damage by providing near-instantaneous detection of a rise in temperature in light water moderators.

Super reliable and simple in design, Edison detectors eliminate complex electronic components. Some are rated at 0.8 seconds maximum response time and the high temperature types give an accuracy of ±1.0% at 750°C. Radiation- and corrosion-resistant, Edison detectors have quick disconnect features for reduction of installation and maintenance time.

Write for Bulletins 3016 and 3036 for information on types of Resistance Temperature Detectors and remote temperature monitoring systems for every purpose.

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®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

No oil filters.
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No internal lubrication to contaminate air handled.
No internal wearing parts.
No valves, pistons, or vanes.
Non-pulsating pressure.
Original performance constant over a long pump life.
Low maintenance cost.

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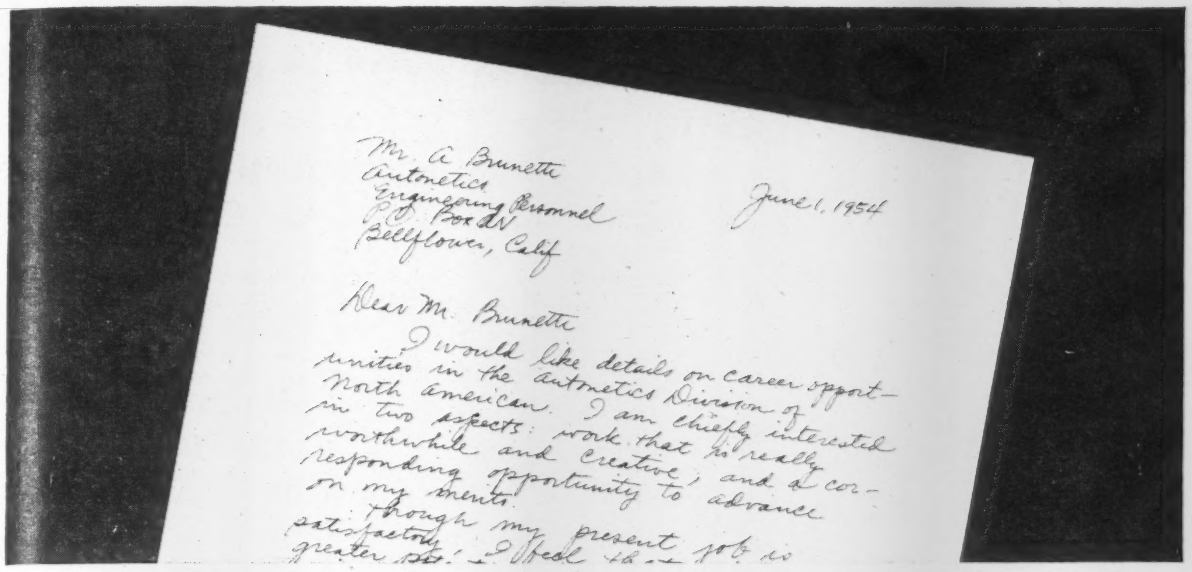
Mr. A Brunetti
Autonetics
Engineering Personnel
P.O. Box dV
Bellflower, Calif
June 1, 1954
Dear Mr. Brunetti
I would like details on career opportunities in the Autonetics Division of North American. I am chiefly interested in two aspects: work that is really worthwhile and creative, and a corresponding opportunity to advance on my merits.
Though my present job is satisfactory, I feel there is greater

This letter moved a man ahead 5 years

Two years ago a man took 10 minutes to write this letter. Today he enjoys the responsibility and professional standing in the AUTONETICS Division of North American that might have taken 7 to 10 years to achieve in other fields.

THE FIELD AT AUTONETICS—A FIELD OF OPPORTUNITY

Now under way at AUTONETICS are nearly 100 projects, comprising some of the most advanced and progressive work being done today in the fields of Electronics, Electro-Mechanics, Control Engineering and Data Processing.

You will work on automatic control systems of many kinds, for manned and unmanned vehicles. Every state of the art is represented, from preliminary conception right through flight testing. Facilities are the finest obtainable. Your colleagues will be men of ability and imagination, of the highest professional standing.

The long-range potential in this field is truly limitless. The techniques being developed at AUTONETICS today will have the widest application in the industrial methods of tomorrow.

You owe it to yourself to consider how far you can advance by entering this exceptionally promising field right now. Here are the opportunities:

COMPUTER SPECIALISTS • COMPUTER APPLICATION ENGINEERS • ELECTRO-MECHANICAL DESIGNERS • ENVIRONMENTAL TEST ENGINEERS • ELECTRONIC COMPONENT EVALUATORS • INSTRUMENTATION ENGINEERS • FIRE CONTROL SYSTEMS ENGINEERS • FLIGHT CONTROL SYSTEMS ENGINEERS • ELECTRONIC RESEARCH SPECIALISTS • AUTOMATIC CONTROLS ENGINEERS • ELECTRONIC ENGINEERING WRITERS • INERTIAL INSTRUMENT DEVELOPMENT ENGINEERS • PRELIMINARY ANALYSIS AND DESIGN ENGINEERS • RELIABILITY SPECIALIST

Write your letter today. Decide now to get the facts, so you can make the most of your potential. Just put your address and brief qualifications on paper—handwritten will be fine. Reply will be prompt, factual, confidential.

Write: Mr. A. Brunetti, Autonetics Engineering Personnel, Dept. 991 -12IA, P. O. Box IA, Bellflower, California

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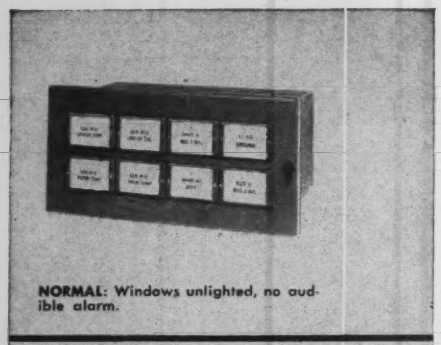
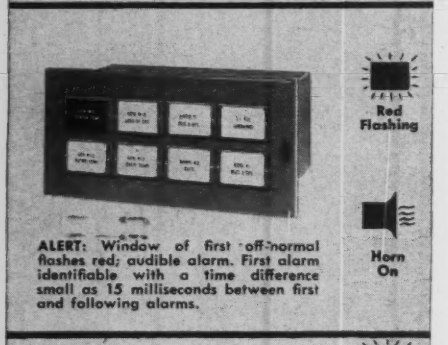
AUTOMATIC CONTROLS MAN HAS NEVER BUILT BEFORE

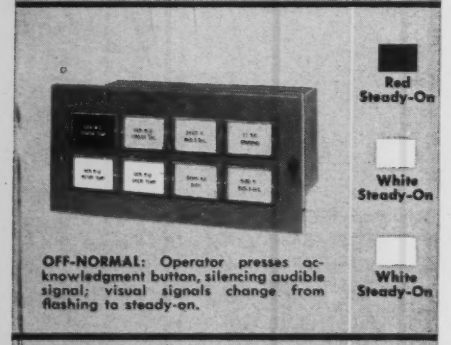


NORMAL: Windows unlighted, no audible alarm.

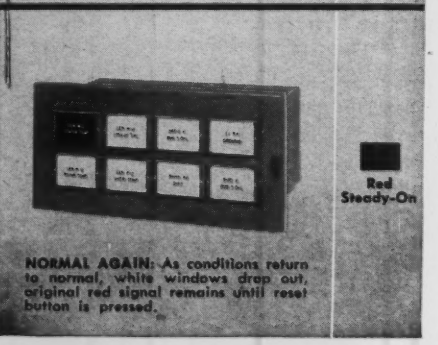


ALERT: Window of first off-normal flashes red; audible alarm. First alarm identifiable with a time difference small as 15 milliseconds between first and following alarms.

ALERT: Subsequent alarms indicated by flashing white windows now added to above condition. Signals lock in on momentary contact.



OFF-NORMAL: Operator presses acknowledgment button, silencing audible signal; visual signals change from flashing to steady-on.



NORMAL AGAIN: As conditions return to normal, white windows drop out, original red signal remains until reset button is pressed.

Panalarm "VS" Annunciator identifies first off-normal from subsequent alarms for rapid corrective action

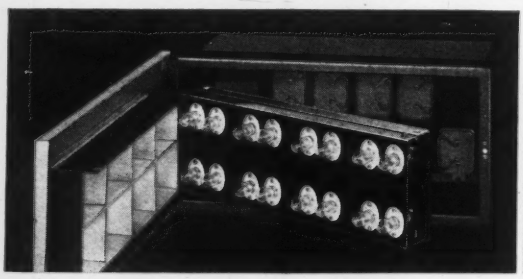
You gain the control advantages of an audio-visual information system, not just an alarm system, with the Panalarm "50VS" Visual Sequence Annunciator. This is particularly valuable when one off-normal condition will cause a "chain-reaction" of off-normals. Typical Panalarm applications are found in the process industries and among users of automatic machinery.

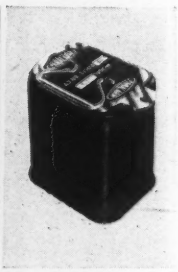
The original off-normal is clearly identified, enabling the operator to take immediate, corrective action. A considerable saving in down-time can often be effected simply by knowing the original source of trouble.

Panalarm "50VS" is completely flexible in setting up various sequential groups. Any number or combination of signals may be grouped as an independent sequence, and the groupings may be changed at any time by simple jumpers on the terminal block. Signals may be either illuminated nameplate or bullseye indicators, combined with a horn, bell or other audible signal. Signaling is simple and positive. A typical sequence is illustrated on the left.

Write for literature on the "50VS" and other Panalarm Annunciator Systems. A Panellit sales engineer will be happy to make a survey of your production operation to determine whether a Panalarm system can help increase efficiency and safety in your plant.

All Panalarm Annunciator Systems are completely modular, permitting future growth and changes. The photographs below illustrate a typical Panalarm Cabinet with illuminated nameplates and the hermetically sealed Panalarm "50" plug-in relay unit. Components throughout are ruggedly built to instrument standards for continuous, dependable duty. Entire Panalarm system is suitable for Class 1, Division 2 installations.





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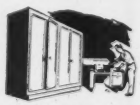
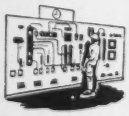
Engineered Information Systems for Industry



Panalog Information Systems



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For more information circle **47** on inquiry card.

Biographies of significance

SIGNIFICANCE

Professor John Trimmer occupies an imposing position in the field of instrumentation. His original studies into the information-entropy relation, which seek to relate the instrument and data function into a universal entropy concept, have stimulated the imagination of thousands of instrument specialists; his many provocative papers have explored new concepts in basic instrumentation; he developed one of the earliest college courses in general instrumentation; his text *The Response of Physical Systems* did much to bring the field of dynamic response to its present position of importance. All of these are but a part of his contributions to our field of instrumentation, contributions which we are proud to acknowledge this month.

JOHN D. TRIMMER

John Trimmer was born in Washington, D. C., in 1907 and grew up in York County, Pennsylvania. His secondary schooling was at York County Academy, in York. Then he went to Elizabethtown (Penna.) College (A.B., 1926), Pennsylvania State University (M.S., 1933) and University of Michigan (Ph.D. in physics, 1936). He is married and has two children.

He had some high-school teaching experience before getting his Ph.D. Afterwards, he worked a year and a half in industrial acoustics, a field closely related to his thesis research.

His introduction to instrumentation came under C. S. Draper at M.I.T. He worked with Draper, with considerable emphasis on vibration measurement, until 1941, when he shifted to war work in underwater acoustics. Later he moved to Oak Ridge to join in the project of electromagnet separation of isotopes.

After the war, in 1946, he joined the Physics staff of The University of Tennessee on a part-time basis to develop a general instrumentation course. As a clinical counterpart to this academic effort he worked with the Oak Ridge National Laboratory group on reactor controls, particularly the MTR project (see page 2408 for pictures of the MTR reactor). More recently he has taken an interest in the controlled (?) thermonuclear reaction—AEC's Project Sherwood. On September 1, 1956, he began a leave from the University to work with the newly-formed Systems Planning Division of Bendix Aviation Corporation, where his duties are carrying him deeper into the nuclear age.

His early publications include his thesis in physiological acoustics, and other papers in acoustics and electronics. Reflecting his war-time Oak Ridge experience is "High Voltage Problems," by John Trimmer and Harry Pearlman, Vol. 9 of Div. 1 of the National Nuclear Energy Series. On reactor control he has written various reports and manuals for ORNL, and has collaborated with W. H. Jordan on a paper "Instrumentation and Control of Reactors," *Nucleonics*, Oct. 1951, and on the material of Chapters V and VI of *Principles of Nuclear Reactor Engineering*, edited by S. Glasstone, Van Nostrand, 1955. He also wrote a chapter in the book edited by Wakefield, *Nuclear Reactors for Industry and Research*, Instruments Publishing Co., 1954.

To general instrumentation he has contributed his text, *Response of Physical Systems*, Wiley, 1950. The response concept is now one of the most important in the entire field of automatic control; his book was not only one of the first, it is still, and will continue to be, an accepted text for this important aspect of control analysis and design. His many papers have explained new concepts of our field, including "Instrumentation and Cybernetics," "The Challenge of Instrumentation as a Science," and "Measurement as a Human Activity." Concern with instrument specification led him to give consideration to the more general taxonomy of all man-made objects.

As a member of the Physics Department of the University of Tennessee, he has sought for common ground between physics and instrumentation, and has found interesting fields of study in the information-entropy relation, and in the relation of the quantum uncertainty to more general errors of measurement.

Discussing his family, hobbies, and reading habits, John tells us, "My favorite game has been tennis, but maybe I'm getting old—I don't play much any more. I bought my son a racquet but he didn't respond, so there are some things about response that I still need to learn. My daughter shows talent with the violin to the point that her father's piano playing looks strictly amateurish. My two favorite truisms on instrumentation are 'To control a system, you don't have to understand it—but it helps!' and 'There's only one way an equation can be linear, but a million ways it can be nonlinear.' The first of these (and, come to think of it, the second also) are highly relevant to Sherwood. As to *I&A*, I've been a reader for many years, and I want to congratulate you on some of the fine things you've been doing. I think the series on 'Digital Automation' is especially timely and well-done."

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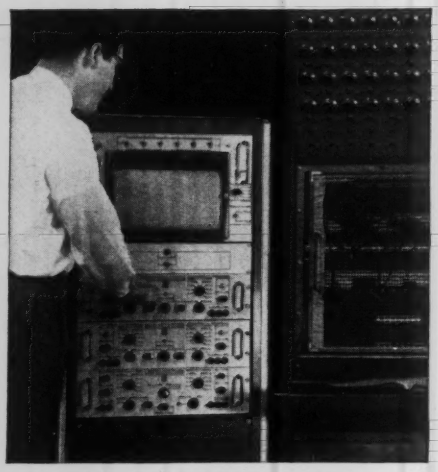
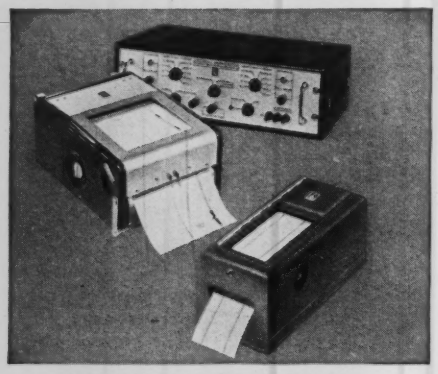
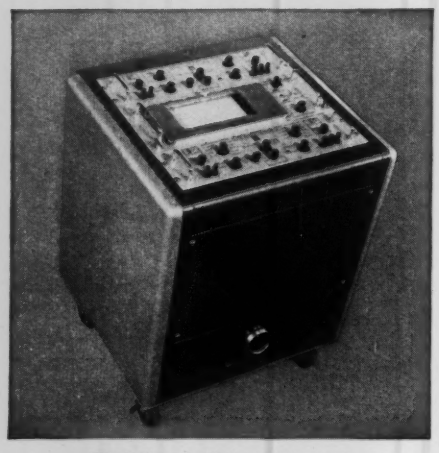
There are more channels of Brush industrial direct-writing



Rack mounted system



Portable instrumentation



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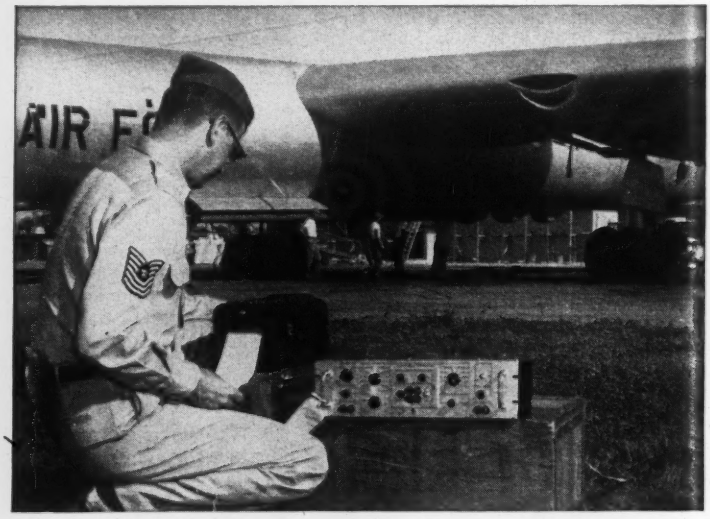
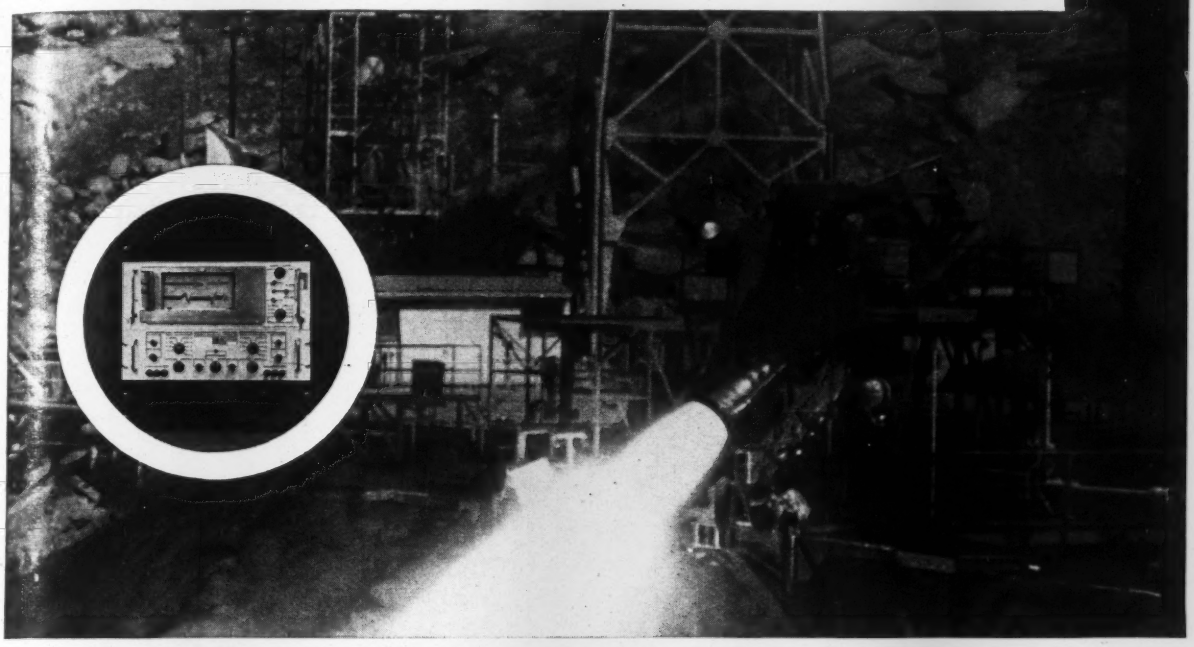
For the very best engineering performance in testing and development—use instrumentation proved by experience throughout the years. Get the facts from your Brush Representative, or write us.



Checks bomber refueling. Brush instruments are rugged and durable, maintain accuracy in field use. Here they record surge pressures in gas tanks of a Strategic Air Command B-36 during refueling. For top performance, bomber must be refueled in a hurry, yet flow rate of 600 gallons per minute posed a pressure problem. Brush Recording Systems provided necessary facts.

For more information circle **48** on inquiry card.

oscillographs in use than all other makes combined.



Tests the mightiest engines ever built. Engineers at ROCKETDYNE, a Division of North American Aviation, Inc., use Brush Recording Systems in developing rocket engines for intercontinental guided missiles. This equipment directly records stress, accelerations, and acoustic values when engines are under test. Considered one of ROCKETDYNE's most stable recorders, this unit has the advantage of mounting readily into their relay racks.

"Mechanical stomach" for elevators. Westinghouse makes sure that its elevators give you a smooth ride. Instrumentation consisting of an accelerometer and a Brush portable oscillograph is shown here on a "trial run". Recorded test data helps develop elevator controls that produce the best acceleration pattern for passenger comfort.

For complete information write Dept. A-12.

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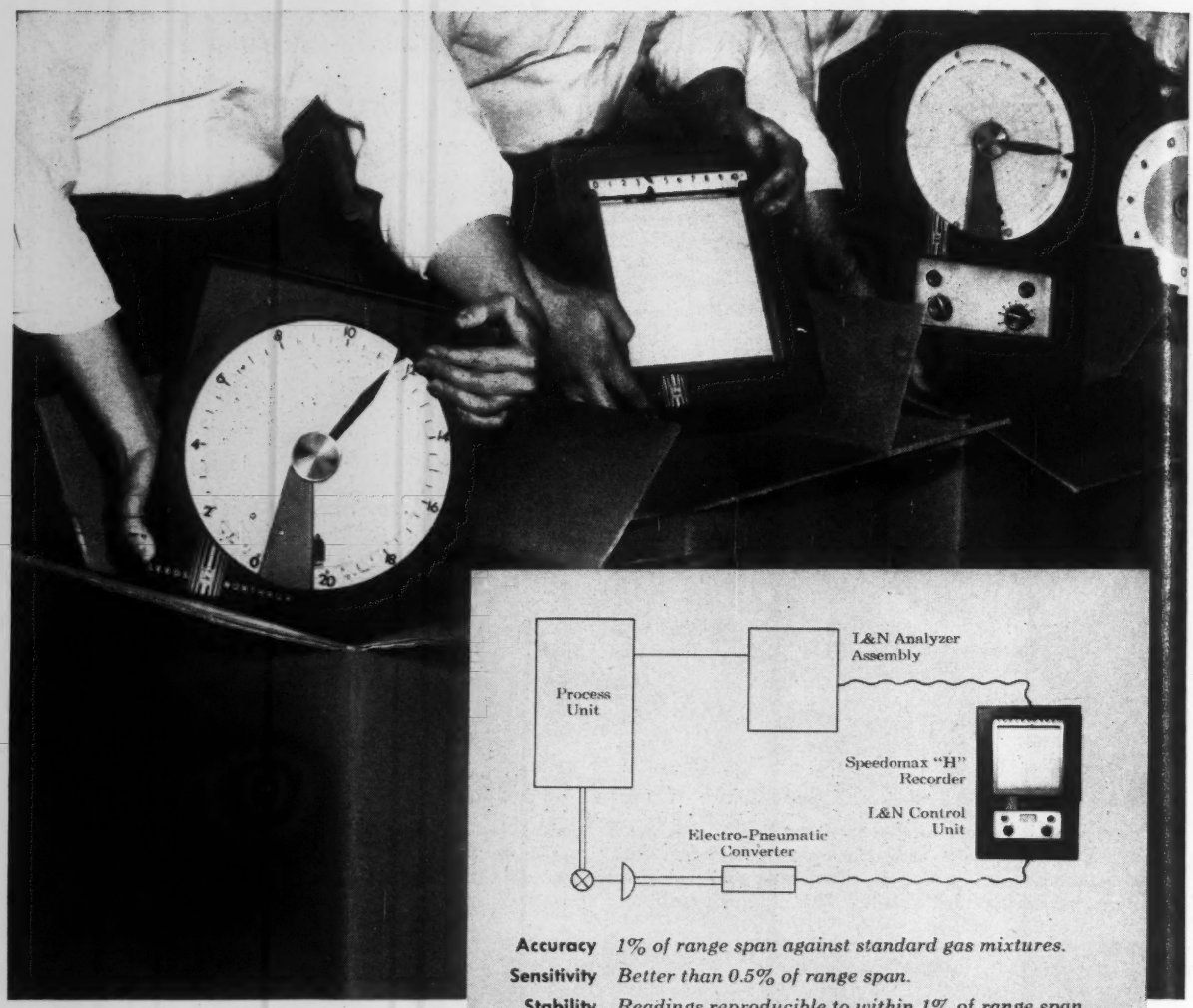

Accuracy	*1% of range span against standard gas mixtures.*
Sensitivity	*Better than 0.5% of range span.*
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Filling the demand for economical Process-Gas Analysis

. . . is our new family of compact Speedomax® Type H thermal conductivity recorders and controllers. They're teamed with established L&N thermal conductivity cell equipment for an economical new approach to process gas measurement and control.

These Speedomax H instruments couple the most-wanted performance features of their well-known Speedomax G parent with small (11″ wide) size, and economies in price. Modern manufacturing methods cut production costs and delivery time without sacrificing the resolution and operating precision for which process men specify Speedomax.

Control through the Speedomax H instruments can be either all-electronic or electro-pneumatic. The 3-action Series 60 Control Unit, used for either form of control, plugs compactly into the Speedomax case. Its replacement parts are also plug-in for service ease. Ranges available include: 0 to 20% CO_2, 0 to 15% SO_2, 0 to 20% SO_2, 95 to 100% H_2 in O_2, 95 to 100% O_2 in H_2, 0 to 100 uncalibrated.

Want details? Write for Folder ND46-91(6) to Leeds & Northrup Company, 4955 Stenton Avenue, Philadelphia 44, Pa.

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INSTRUMENTS and AUTOMATION

AUTOMATION: The use of devices—mechanical, pneumatic, hydraulic, electrical and electronic—for making automatic decisions and efforts.—*M. H. Aronson*, Editor

Editorial

Q.E.D.

WITH this issue of *I&A*—Vol. 29, No. 12—your editors conclude 29 years—and begin their 30th year—of serving you. It is fitting on such an occasion to pause a little and reflect on the accomplishments and developments of the past year, with a view to defining pathways into the future.

Perhaps it would be appropriate to start with what we did *not* say or do. We did not editorialize on the need for cross-fertilization of ideas, the job-making aspects of automation, the value of an integrated systems approach to control problems, the need for standards, the need for more teachers and students, and other "I Love Mother" themes. Everybody knows—or should know—that ideas and conferences are wonderful, that control of a system involves all elements of that system, that standards are the *sine qua non* of instrumentation, that our educational system is deteriorating, and that mothers should be loved. Hence, when we have had nothing *constructive* to add on these subjects, we have chosen other subjects.

Editorially, we have fought hard through the past year to resist the trend to growing discussion of "The Effect of Automation on Our Economy." We have shown that automation is a technique for increasing *productivity*, a technique that must be used whenever economic, and one that has little if any effect on the economic health or *production* (as opposed to productivity) of a country as a whole. We have proved this point logically and statistically, and repeated it over and over.

Another of our editorial themes has been to emphasize the importance of analyzing industrial operations at the operating level by analog computer. This theme is in keeping with our entire basic philosophy, which might be expressed as "Use An Instrument to Solve Your Problems." Others talk about integrated systems concepts; our emphasis has been that an instrument exists which can solve the efficiency problems of any integrated system, qualitatively and quantitatively. In this respect, you have received a basic education on the principles and applications of the analog computer.

A third editorial theme has been an interpretation of the "new technologies" and their effects on all technology of the future. All measurements of any type can be classified as either analog or digital, and a new technology has emerged in each of these two basic fields. The analog technology is that of system analysis via simulation, as has been mentioned. The digital development has been the emergence of complete new systems and concepts of logical digital decision-making techniques. In the past year you received a series of articles on this subject which will rank with the most important published works of our times. In addition, you received a practical introduction to the general-purpose digital computer.

Thus, in both the analog and digital fields, which encompasses all of measurement and control, you received basic educational material, at all times de-emphasizing the generality in favor of the instrument and its use.

There were other important "firsts" in the past year. The series on control valves was the first such coverage in series form, and will be the cornerstone for other needed works in this field. Its treatment of valve positioners and combination valve actuators was especially noteworthy.

A new concept that opens a new dimension to process control is the technique of "Optimal Control." This was brought to you as a national exclusive.

In data handling, you received a complete résumé of analog-to-digital converters and data handling systems—from slow electromechanical types to microsecond electronic systems, and including the exciting new random-access memories of multimillion-bit capacity.

Our never-ending program of electronics education, which began with the series on "Instrument Electronics," was carried forward via 100 basic circuits in the "Electronic Circuitry" feature. The demand for these circuits is such that they soon will be published in book form.

Continuing another editorial theme that has been consistent for 29 years, we have dealt lovingly with each new instrument that has been made commercially available by the instrument manufacturer. More than 2000 new instruments and 2000 new catalogs and brochures were reviewed for you, all indexed carefully by variable. The value of this service is indicated by the fact that in 1956 *I&A* forwarded to the instrument manufacturers of our country more than 120,000 reader inquiries for more information.

All these—analog simulation, binary arithmetic, digital computation and decision making, random access memories, combination valve positioning, electronic circuitry, and optimal control—are the "new technologies." In reviewing our efforts of the past year we are gratified to see that each has been thoroughly and educationally covered.

For the future, your editors rededicate themselves to serving you as in the past, interpreting each new technological development as it appears—clearly, honestly, factually, and educationally.

Happy New Technologies in a Happy New Year
Milt and Your Editors

ISSUES
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and thereby registers the end of twenty-nine years of *Instruments and Automation's* service to users of measurement and control devices—service to THE UNITED STATES OF AMERICA

The entire staff of *Instruments and Automation* wishes you

Season's Greetings

A NATURAL TIE-IN

for equipment manufacturers . . .

MILITARY AUTOMATION MAGAZINE ⟷ FIRST MILITARY AUTOMATION EXPOSITION

MILITARY AUTOMATION magazine—to make its debut in February 1957—will preview the

FIRST MILITARY AUTOMATION EXPOSITION—to be held March 18 to 21, 1957 at the New York Trade Show Building, 500 8th Avenue.

ADVERTISERS who plan to use space in **Military Automation** are urged to consider the advantages of exhibiting in a Show devoted strictly to electronics, and control equipment and components, as applied by and for the military. (IRE's annual show will be at the Coliseum the same four days. Buses will shuttle engineers between the two shows.) Richard Rimbach Associates, who managed the recent and highly successful Third International Automation Exposition, will also manage the First Military Automation Exposition.

EXHIBITORS who plan to display their MIL-spec equipment at the First Military Automation Exposition should also consider the unique advertising values available through the pages of **Military Automation** magazine. "King-size" properly describes M-A . . .its format, its audience, and its editorial staff.

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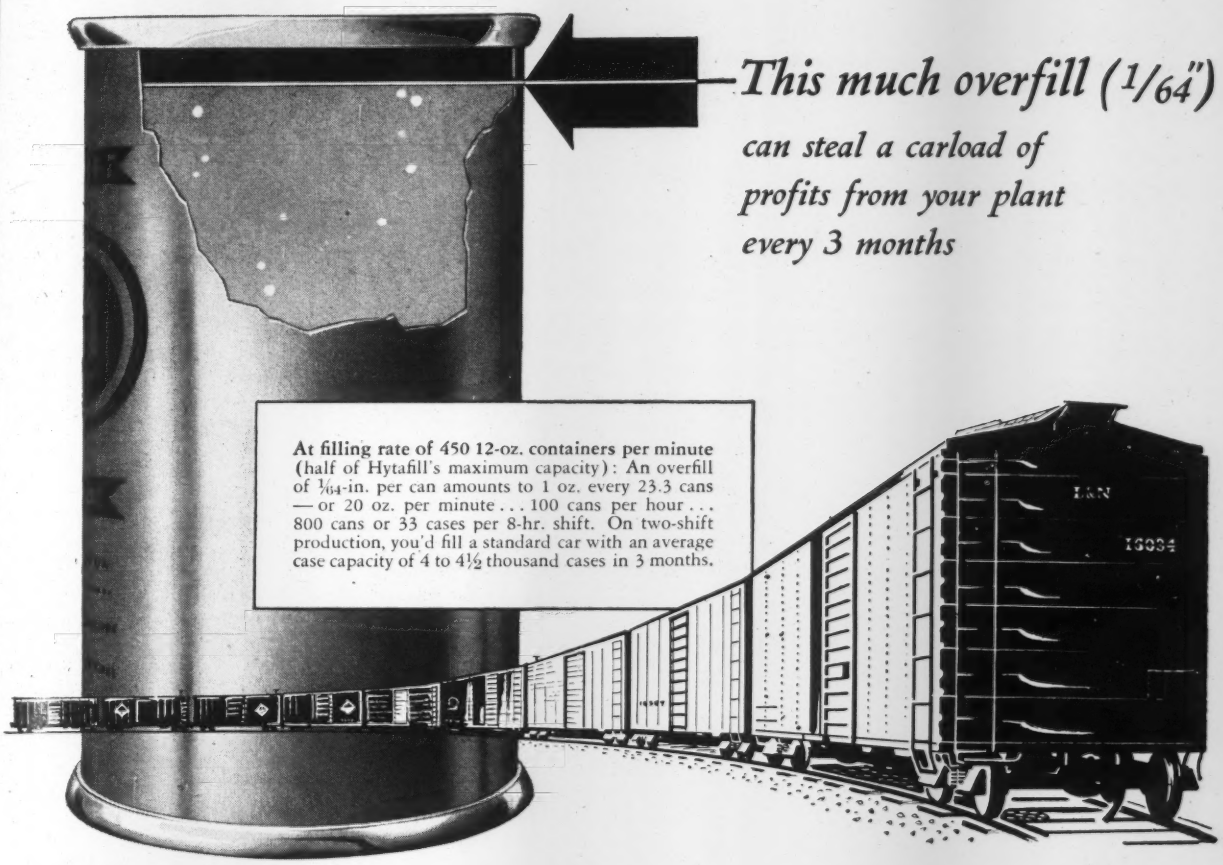
This much overfill (1/64")
can steal a carload of
profits from your plant
every 3 months
At filling rate of 450 12-oz. containers per minute (half of Hytafill's maximum capacity): An overfill of 1/64-in. per can amounts to 1 oz. every 23.3 cans — or 20 oz. per minute . . . 100 cans per hour . . . 800 cans or 33 cases per 8-hr. shift. On two-shift production, you'd fill a standard car with an average case capacity of 4 to 4½ thousand cases in 3 months.

G-E HYTAFILL® X-RAY MONITOR "sees" wasteful overfill

. . . helps you stop it immediately

Whether you package liquids or free-flowing solids—*overfill* may be stealing thousands of profit dollars annually. If for instance, you're canning beer, this will add considerably to your barrel taxes.

Not so in plants equipped with General Electric Hytafill. Installed on your conveyor line, this high-speed x-ray monitor detects variations of 1/32" (± 1/64") in filling opaque containers . . . actuates automatic reject mechanism . . . warns you to make immediate adjustment to filling apparatus.

Hytafill gives you both *overfill* and *underfill* inspection on every container — at a maximum rate of 900 per minute. *Full-time* detection at minimum cost! Most leading brewers, and a host of canners and packers of other products, are incorporating General Electric Hytafill equipment not only in new construction, but in their modernization programs as well. How about you?

Fast installation — adapts to existing conveyor lines. Hytafill consists essentially of a tube head and detector with remote control. Requires very little space. Tube head and detector are sealed against moisture . . . may be washed with steam and hot water. For full details on Hytafill, call your nearest General Electric x-ray representative. Or write X-Ray Department, General Electric Company, Milwaukee 1, Wisconsin, for Pub. BL-124.

Progress Is Our Most Important Product

GENERAL ELECTRIC

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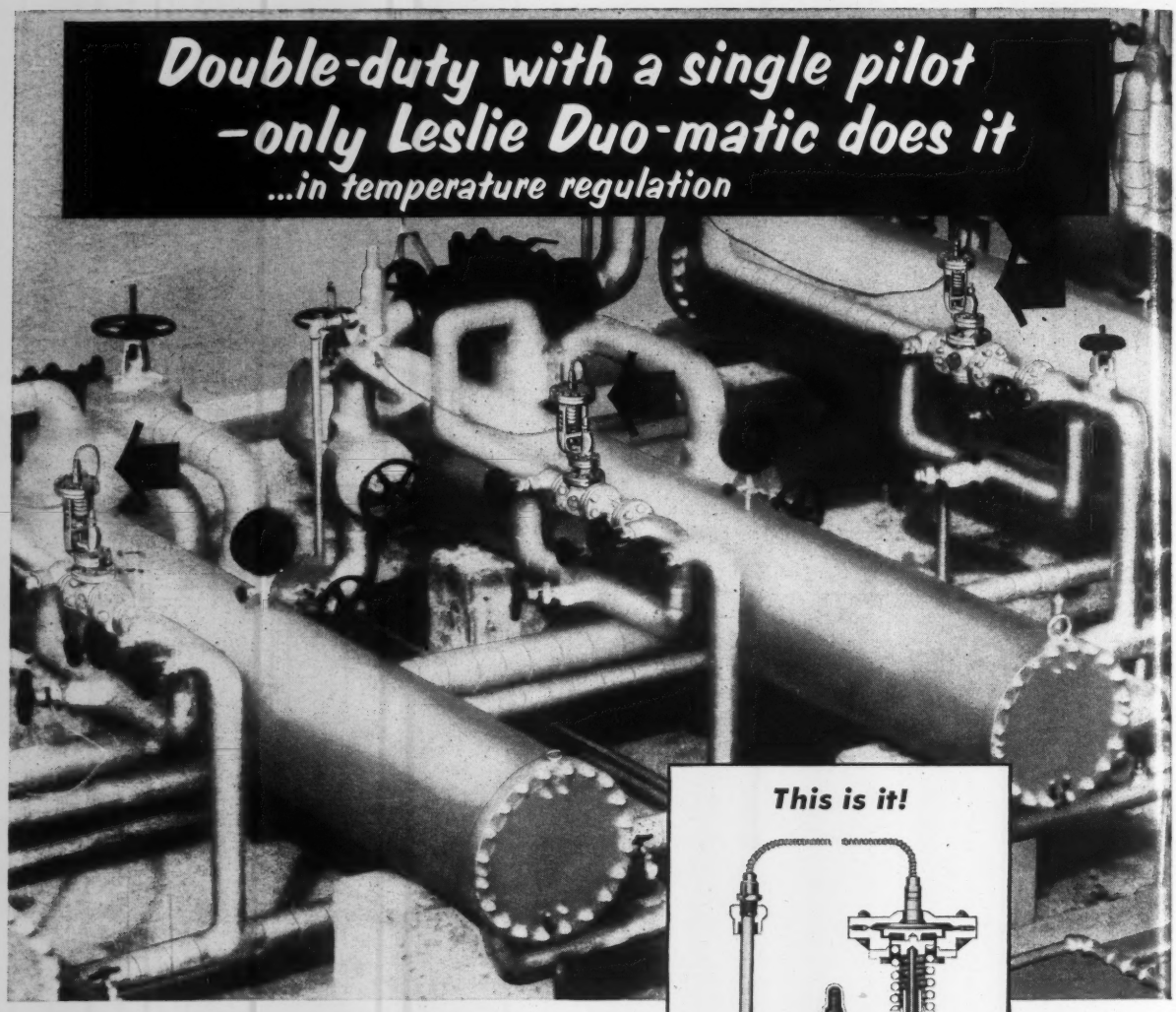
Double-duty with a single pilot —only Leslie Duo-matic does it ...in temperature regulation

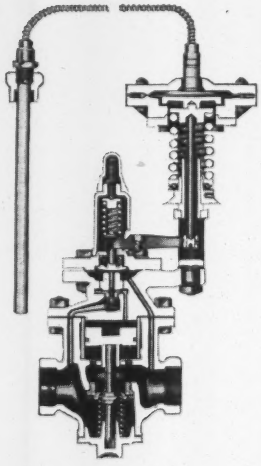


The Duo-matic Leslie temperature regulator for controlling steam flow is a single unit, with a *single* internal pilot valve—yet it controls automatically both temperature and pressure conditions. No hunting or cycling on low flows . . . eliminates temperature "droop" on heavy loads.

Simplified piping and better control of fuel oil heaters, instantaneous and storage type heaters, driers, process heaters, kettles, open tanks, ovens, degreasing machines, steam tables, sterilizers, etc., more than offset the initial cost of this superior regulator.

Investigate "dual-function" Duo-matic regulators — proven in service for over 19 years of applications.

This is it!



Leslie Class LTCO Duo-matic temperature and pressure regulator

Write for Bulletin 5307

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ASCO

one source for the most complete line of

SOLENOID VALVES

When you discuss solenoid valve requirements with an ASCO Engineer, you are benefiting from the design and development experience of half a century. The ASCO specialist can recommend the *right* valve for your needs because that leadership has resulted in the more than 1300 types of solenoid valves now available:

Two way valves in pipe sizes from ⅛" to 6" – for temperatures to 600° F. – for pressures to 1500 p.s.i.

Three way valves in pipe sizes from ⅛" to 6" – for temperatures to 450° F. – for pressures to 1000 p.s.i.

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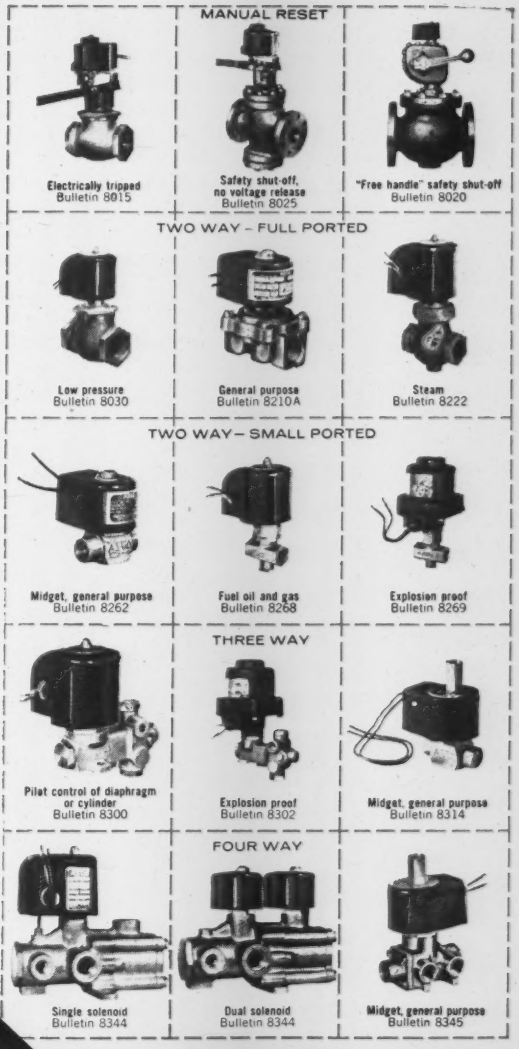
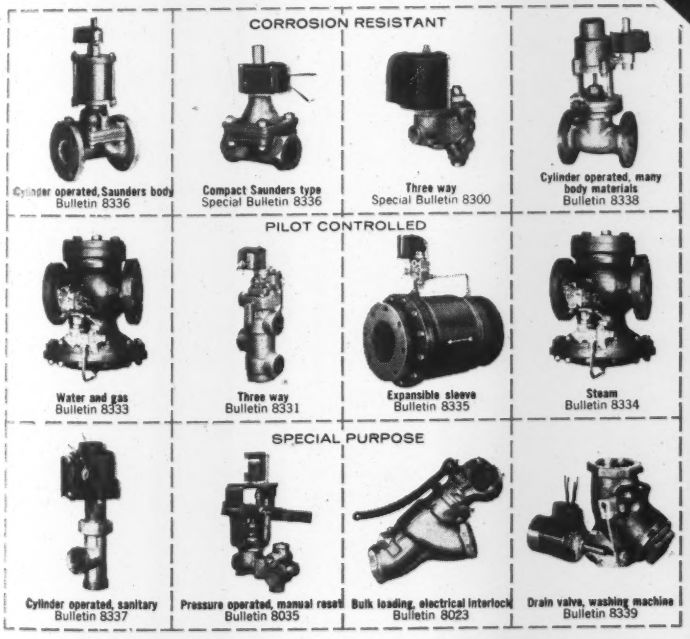
And ASCO can supply you with standard, explosion-proof or water tight enclosures – Class A and Class H coils – a wide range of body materials including cast iron, brass, bronze and stainless steel.

There's *one* source that solves virtually any solenoid valve problem—ASCO. Why not have the ASCO Engineer call—or write for your copy of ASCO Solenoid Valve Catalog No. 24.





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Automatic Transfer Switches
Electromagnetic Controls
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Automatic Switch Co.

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PROBLEM:
how to produce true linear adjustment of the ratio between input and output in a 3-15 psi pneumatic system.
SOLUTION:
THE NEW HAGAN '3-15' RATIO RELAY

This unique Hagan device fills a long felt need in pneumatic process control systems for a relay which will permit the operator to adjust the *ratio* between input and output signals.

Rugged and reliable, and requiring small space, the Hagan Model '3-15' Ratio Relay produces a true linear proportional change in the output signal. Designed primarily for use with 3-15 psig signals, the '3-15' is easily adjusted to change the minimum input and output bias values to any point between zero and six psig. The actual maximum input and output signals may be any value up to 20 psig.

The Hagan '3-15' is ideally suited for any process control systems such as fuel to air ratio in combustion processes, ratio of gases in gas mixing or in the proportional feeding of chemicals. See your Hagan engineer, or write for full details. Ask for Specification Sheet SP4315.

HAGAN MODEL '3-15' RATIO RELAY

- True ratioing around 3 psig input
- Compatible with any signal system whose range is between 0 and 20 psig
- Simple means for altering suppressed scale setting, if desired
- Mounting Plate dimensions—6⅜" x 6⅜"
- Input range—0-20 psig
- Output range—0-20 psig
- Minimum Ratio setting—0.3 to 1
- Maximum Ratio setting—3.75 to 1
- Suppressed Scale Range (adjustable)—0-6 psig

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HAGAN BUILDING, PITTSBURGH 30, PA.

Systems and Components for: Process Control, Metallurgical Furnace Control, Boiler Combustion Control, Aeronautical Testing Facilities • Industrial Water Treatment • Chemicals for Water Conditioning

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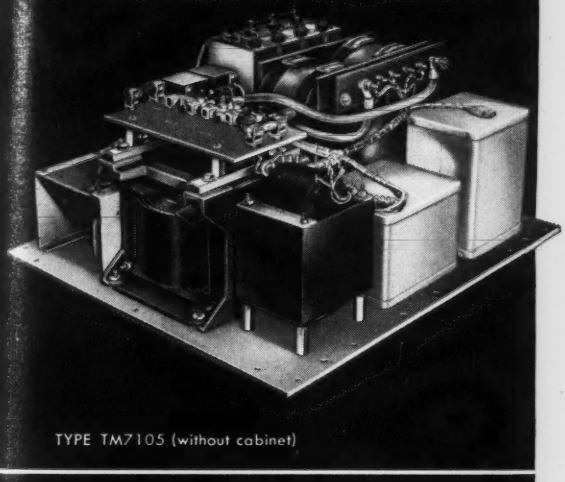
NO TUBES
to replace . . .
NO TRANSISTORS
NO MOVING PARTS
to wear out

STABILINES type TM (Tubeless Magnetic) are the newest automatic voltage regulators offered by The Superior Electric Company. Without tubes, moving parts or transistors, the TM's provide constant voltage regardless of line or load changes. Where failure at any time under the most adverse operating conditions cannot be tolerated or where maintenance is not a possibility for long periods of time, a STABILINE type TM is a necessity.

STABILINE* TYPE TM
(Tubeless Magnetic)



TYPE TM7105 (without cabinet)

TYPE TM7105 (with cabinet as mounted on wall)

FOR UNATTENDED LOCATIONS

- Microwave relay stations
- Remote installations

FOR CRITICAL APPLICATIONS

- Where sudden need for tube replacement can be costly (at a critical time in a process) or impossible (at an unattended location)
- Where conditions cannot tolerate moving parts.

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STABILINE TYPE TM CHARACTERISTICS

INPUT: 95-135 volts, single phase on nominal 115 volt types
195-255 volts, single phase on nominal 230 volt types

OUTPUT: Adjustable 110-120 volts on nominal 115 volt types
Adjustable 220-240 volts on nominal 230 volt types

ACCURACY: 1 volt band for line voltage variations and/or load magnitude and power factor changes

FREQUENCY: 60 cycles ±5%

WAVEFORM DISTORTION: 4% maximum

RESPONSE TIME: Less than ½ second for ordinary line and/or load changes. For extreme conditions of line and load changes, maximum response time is 2.0 seconds. (Response time is measured from the time of initiation of transient to the time when output voltage is within and remains within rated limits)

LOAD: Available in 1.0, 3.0 and 5.0 KVA ratings

POWER FACTOR: 0.5 lagging to 1.0

THE SUPERIOR ELECTRIC COMPANY
712 MIDDLE STREET, BRISTOL, CONNECTICUT

Please send STABILINE Bulletin S157 ☐
Have your representative call ☐

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City.....*Zone*....*State*.....

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Now you can buy a Bailey-built HEAT PROVER Analyzer

Flue gas analysis with a Bailey HEAT PROVER Analyzer at a furnace stack. Per cent oxygen and combustibles is shown continuously.

CONTINUOUS READINGS OF OXYGEN AND COMBUSTIBLES

The famous Cities Service HEAT PROVER Analyzer, formerly available only on loan, is now manufactured by Bailey Meter Company, and you can buy one outright. With this handy portable instrument, you can easily monitor the per cent of oxygen and combustibles in gases.

The continuous readings from a Bailey HEAT PROVER Analyzer enable furnace, kiln, and engine operators to correct combustion variables before costly losses are incurred. Although it weighs a scant 25 pounds, the HEAT PROVER Analyzer is the key to maximum combustion efficiency. With it, the operator can determine the proper proportion of fuel to air at any time.

The two meters on the analyzer show per cent by volume of oxygen and combustibles on either a 20% range span or a more sensitive 4% range. Temperature of flue gases in degrees Fahrenheit is also shown.

Compared with involved, time-consuming Orsat measurements of flue gases, his new portable analyzer offers these advantages:

1. Simultaneous direct readings of oxygen and combustibles.
2. Negligible time lag between combustion change and reading change.
3. Continuous sampling, analysis, and readings.
4. Convenient measurement of temperature.

Ask your Bailey engineer how you can use this instrument to increase combustion efficiency. Or, write today for more information on how this new Bailey HEAT PROVER Analyzer can pay for itself practically at once. G-39-1

Instruments and controls for power and process

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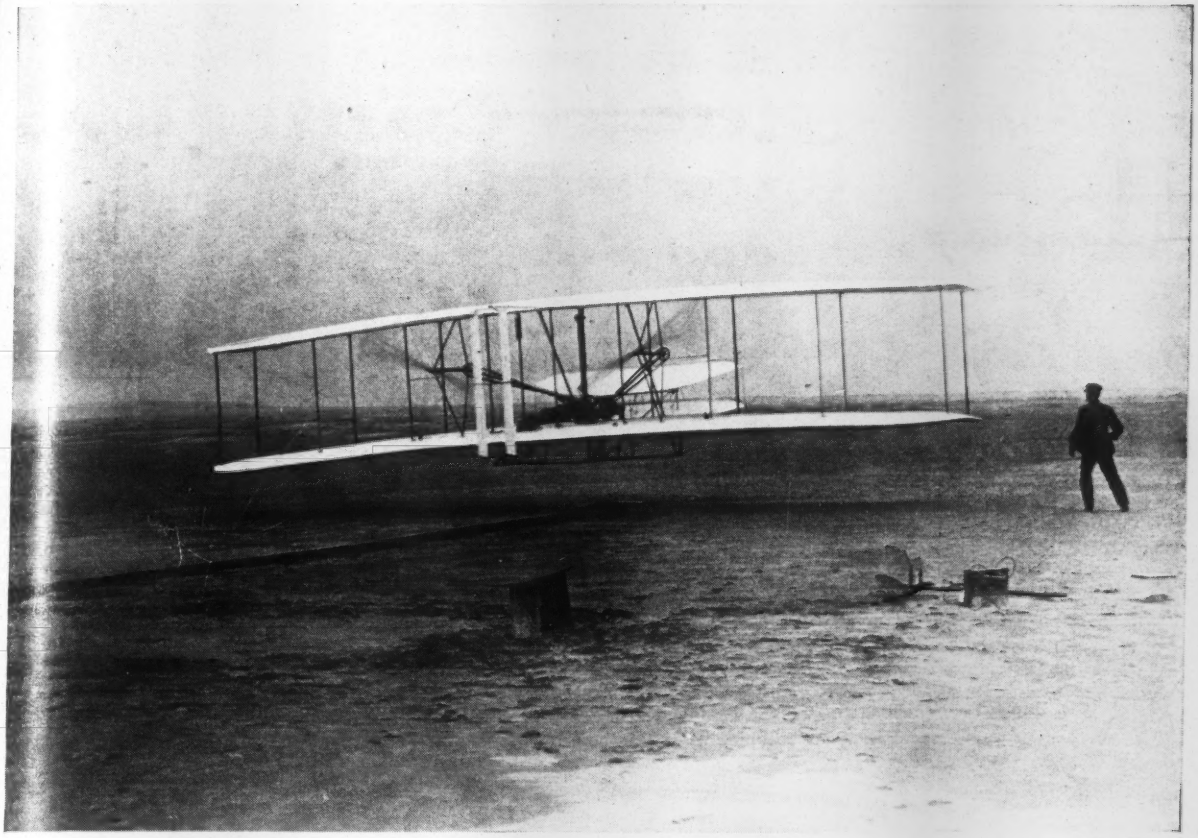

Experiment by two bicycle mechanics, Kitty Hawk, 1903

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You have—in missile engineering!

The Wright Brothers found existing aerodynamics concepts to be unreliable—so they formulated their own. By this ability to see further than accepted doctrine they started the mainstream of aviation development on its way. It is this power to reach beyond standard ideas that has led through every major advance in aeronautical science right up to the remarkable progress now going on in missile engineering.

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Here at North American, we are pioneers in this new era of flight. A supersonic test vehicle, the X-10, is already flying. As a leader in advanced weapons systems, we have the prime responsibility for the SM-64 Navaho Intercontinental Missile. This program is unique because it is *fully integrated;* it covers every aspect of Missile Engineering—including the most advanced developments in supersonic airframe design and manufacture, guidance and control systems, jet and rocket engines, and flight testing.

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NEW Stock-Control System based on VEEDER-ROOT Vary-Tallies

saves time...
speeds production...
stops errors

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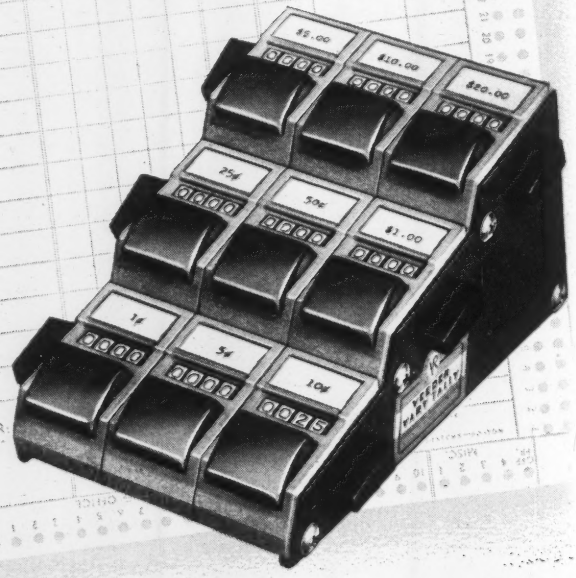
What Production Systems Inc., Waltham, Mass., is doing for the garment industry with its "Quik-Pik" System . . . *you* can do for yourself with a similar system based on Vary-Tallies. And you can count on Veeder-Root to help you. Write:



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"The Name that Counts"

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To build *complete systems reliability* into this airborne computer, IBM submits the finest available components to tests of torturing extremes. Only those that survive are used. But, from this test data, IBM electronic computers figure ways to improve the failures and make those selected even better. In this way, IBM helps strengthen the general reliability of all electronic systems, and give to America's airborne defenders a mighty—and dependable—weapon for guarding the peace.

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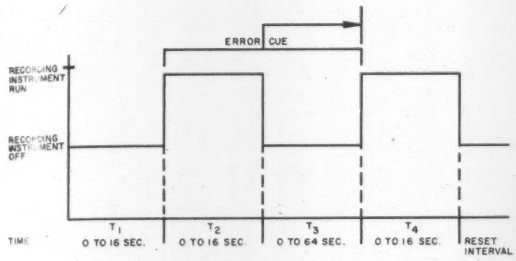

Fig. 14-1. Desired sequence of control in a recording equipment.

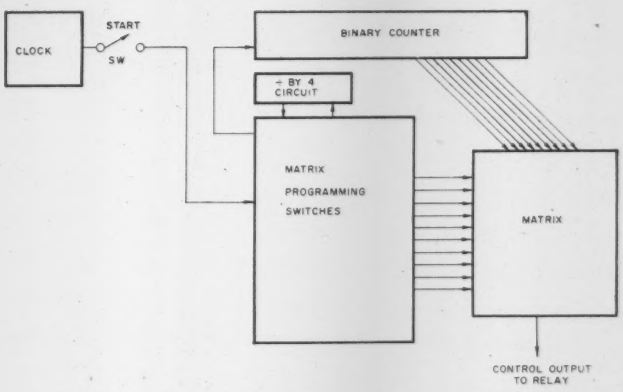

Fig. 14-2. Block diagram of one setup for performing the control sequence desired.

Digital Time and Sequence Control

The binary-wired switch permits simple trunking of a matrix line. Four sets of such switches are used with relays to control a sequence of events in VIAC —the Variable-Interval Automation Controller.

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DIGITAL TECHNIQUES can be applied directly to time and sequence control. In one problem (the operation of a relay in a recorder), a sequence of events was to take place in specific order and with specific time intervals, as shown in Fig. 14-1. The time intervals are such that electromechanical (relay) technique can be used.

The equipment is to be inoperative during the first preset interval of 0 to 16 seconds. In the second interval the equipment is to operate for a preset time interval of 0-16 seconds. In the third interval the equipment is to shut down for an interval up to one minute, plus or minus four seconds. In the last interval the equipment is to operate for an interval of 0-16 seconds. The operator has the responsibility of presetting the four time intervals desired for the sequence. In the event something goes wrong in the process, an error signal is given in the form of a step voltage. It is desired that if this error occurs in the second interval, the equipment is to omit the third interval (shutoff) and proceed directly to the fourth interval. Similarly, if the error signal occurs in the third interval, the equipment is to immediately step to the fourth interval.

There are several ways to approach this problem. The most direct way (but not the most economical) is to use a matrix for each interval of time, with one vertical line representing each second of time (as was done for the pressure-control problem discussed in Chapter 12).

Thus in interval 1 we could use a matrix with 16 vertical lines representing 0-15, and the same for the second and fourth interval. The third matrix would have 16 lines representing 0, 4, 8, etc., to the highest count of 60. These four matrices would have a large number of diodes.

A more economical method (Fig. 14-2) makes use of

1. A clock operating at one-second intervals.
2. A diode matrix and binary-wired switches.
3. A stepping switch.
4. A set of flip-flops.

Note that the basic time interval in this problem is one second, which suggests that the clock be operated at one-second intervals; use is made of a multivibrator circuit to provide these one-second pulses.

A knife switch is shown to start the operation of the sequence in Fig. 14-2; this could be replaced by a relay or pentode gate circuit.

Binary-Wired Switches

To save diodes and circuitry, use will be made of a trunking matrix and binary-wired switches. Fig. 14-3 shows a simple 1-line matrix with binary-wired switches which connect the diodes to represent the number set into the switches. That is, when we set the decimal number 0 in the manual switch SW 3-4, we set the diodes

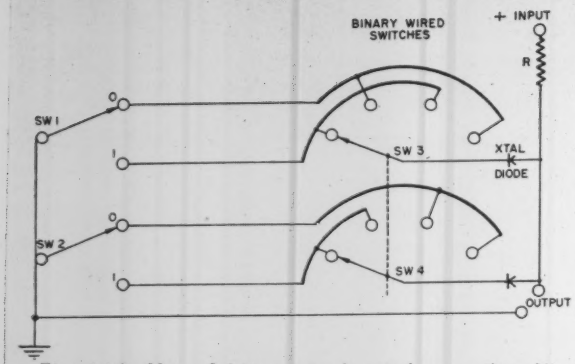


Fig. 14.3. Use of binary-wired switches to "trunk" a matrix line. Ganged switches 3-4 are shown at position 00, whereby input signal reaches the output only when the matrix input is 00, as shown. Any other value of input at left will short out the signal via one of the diodes. When ganged switches 3-4 are advanced one position, the line is activated only on signal 01; in last position, line is activated only on input 11.

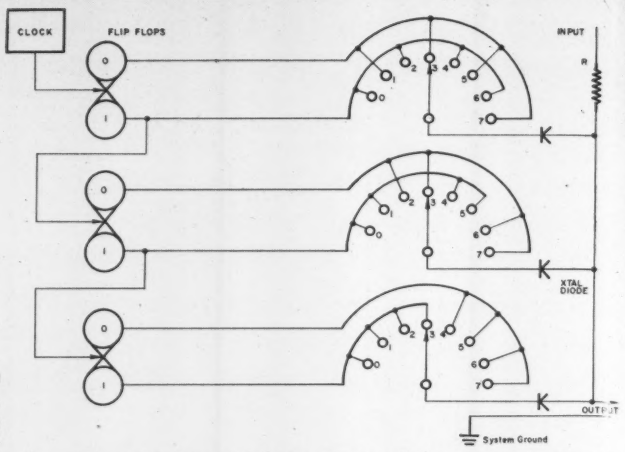


Fig. 14-4. Use of binary-wired switches to trunk a matrix line at any value between 0 and 7. At position shown, line will activate only when input (number of pulses from clock) is 3—that is, 011 (least significant bit is at top).

so that a signal appears at the output only when the input (SW 1-2) is 00, as shown.

Fig. 14-4 shows how binary-wired switches are used to trunk a matrix line so that it can represent all numbers from 0 to 7 (000 to 111). The ganged switches are wired in binary code and are shown in position 3—that is, the matrix represents the decimal number 3 in binary. Note that the switch wiring is, in fact, a binary code since the level connected to the least-significant-bit diodes alternates On-Off-On-Off. The second level alternates On-On-Off-Off and the third level On-On-On-On-Off-Off-Off-Off, which is the way the binary bits 0 and 1 appear in binary numbers written in succession. Thus, if we wire the diode matrix as shown, we can set any number we wish, up to the highest number in the matrix. A matrix to be switched in this manner and counting from 0-7 requires, as shown in Fig. 14-4, three pairs of horizontal lines and, therefore, a three-level 8-position binary switch. To count 0-127 requires seven pairs of horizontal matrix lines and a seven-level 128-position switch. By setting the switch in the correct position, we "trunk" the diodes in the matrix to represent the number selected on the switch.

Matrix for Setting The Four Time Intervals

In the problem at hand, we are dealing with four independent time intervals. This suggests use of four switches and four matrices, each matrix controlled by presetting the switch. These four matrices can be realized by a single matrix if we connect only one vertical line at a time, as shown in Fig. 14-5. This puts us in a position to operate the matrix vertical lines according to the correct sequence of time intervals set in the four switches. First, vertical line 1 is made active by closing the switch. When this interval is completed, we open this connection and close vertical line 2 (within the T2 unit), and so on. This sequence can be controlled by a six-level stepping switch, as shown at the right in Fig. 14-5.

Stepping Switch

The first level (upper right in Fig. 14-5) is used to supply current for the contact closure of the recording device being controlled. Thus, when the stepping switch

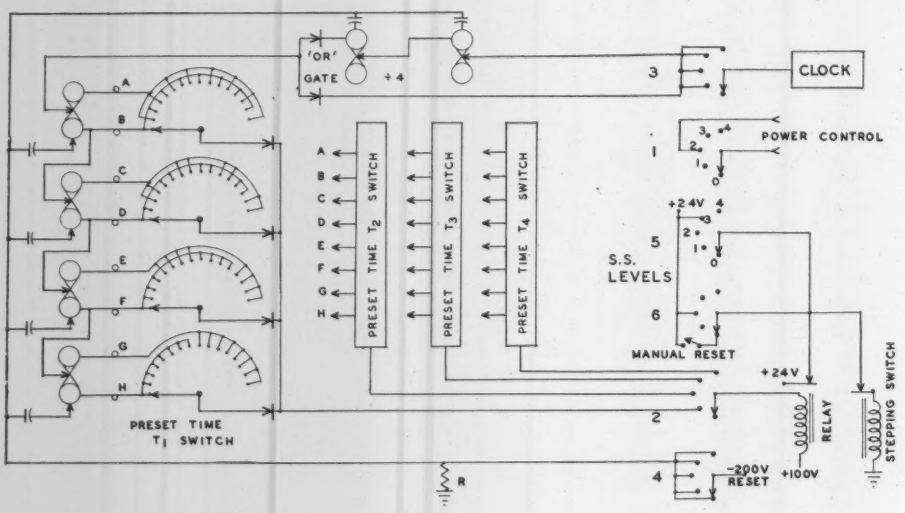
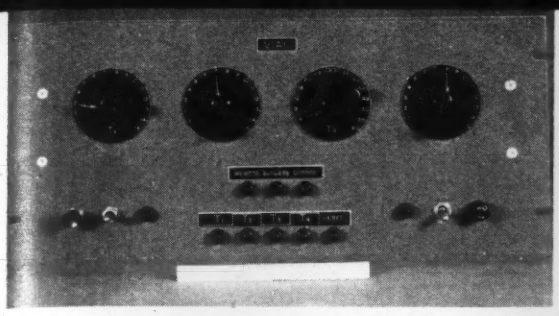


Fig. 14-5. Complete system for interval controller. Clock delivers 1-second pulses to the four flip-flops at left, which are connected to the ganged binary-wired switches that select the time interval desired. Wipers of the timing switches are connected to a matrix line. Interval 1 (Preset time T1) is shown in detail; intervals 2, 3, and 4 are shown only in block form, but are similar—that is, each comprises binary-wired switches and a matrix line. Stepping switch at right has 6 levels or decks. Note that S.S. (stepping-switch) deck 3 is at top right; deck 1 next, etc. (Points 2 and 4 on deck 1 should be shown connected.)



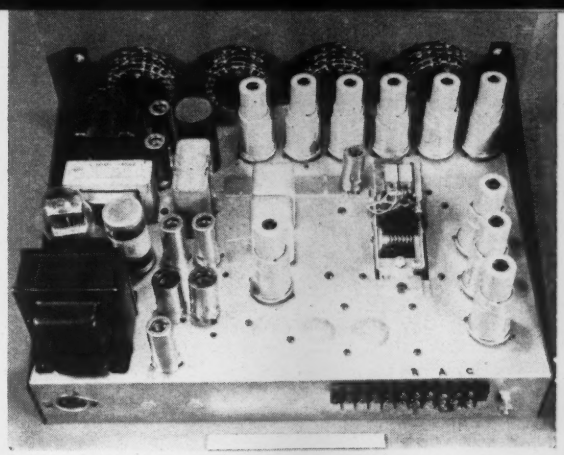


Fig. 14-6. Appearance of the Variable-Interval Automation Controller (VIAC).

is in the first position, no current is supplied to the device. In the second position (after one step) the current is supplied to the device. On the second step, which leaves the switch in third position, the current is again shut off; in the fourth position, current is again supplied. This follows the program required (Fig. 14-1) for control of the device. (Correction: contacts 2 and 4 on this switch should be shown connected together.)

The second level of the stepping switch is used to connect the correct vertical lines of the matrix in order. Thus when the switch is in its first position, only vertical line 1 of the matrix is connected. When the switch steps to position two, the second (and only the second) vertical matrix line is connected. (The second, third and fourth matrix lines are shown only in block form; each is like the first—that is, it comprises four diodes and a 4-level binary-wired switch for selecting the interval desired.) Thus the second level of the stepping switch connects in turn the correct vertical line of the matrix to the stepping-switch drive coil.

We have an additional problem on the third step in that we wish to count in 4's from 0 to 60. This is 16 steps again, but we must take every fourth pulse and put out a single pulse if we are to use the same matrix flip-flops used for the other time intervals. Hence the clock pulses are fed to the third line only after going through two flip flops, which divide the clock output by 4. This is done through the 3rd level of the stepping switch at right (shown at top right in Fig. 14-5).

The flip-flops must be reset at each time interval. Suppose we are counting to, say, seven in the first interval. When the interval is complete the matrix puts out a pulse and steps the stepping switch to the next position. However, the count of seven still stands in the flip-flops and must be cleared out. This is done by use of the fourth stepping-switch level; each step breaks the D-C voltage supply and resets all matrix flip-flops. Note that the stepping switch acts as a memory; at each position it simultaneously connects the correct vertical of the matrix in the order desired (level 2), turns the control current on and off (level 1), puts out a resetting pulse at each change (level 4), and divides the count for the third interval (level 3). This follows our usual principle of having an operational circuit (in the form of a diode matrix) to provide control, and a memory device of some sort to sequence the events in correct order. With one-second control intervals, a stepping switch is adequate; if the sequence were required to occur at high speeds, say milliseconds, complete electron-tube circuitry would be essential, the stepping switch being replaced by thyratrons and gating tubes.

Levels 5 and 6 of the stepping switch (center right in Fig. 14-5) are used to satisfy the requirements that the unit is to proceed to interval 4 in the event of an error signal that arrives while the unit is in interval 3 or 2. The cut-off step signal (the error signal) is connected to position 3 of the fifth level, and to position 2 of the sixth level. Thus if the signal arrives any time during the third interval, the signal passes through the stepping switch and steps the switch one position to interval four, as desired. Similarly, if the signal for cut-off arrives at position 2, the stepping switch immediately steps to position 3, the cut-off signal then passes through the fifth level at position 3 and steps the relay again to position 4 as desired. Momentary loss of current in passing from position 2 to 3 can be eliminated by using bridging wipers.

The entire operation is now controlled according to the program desired. The operator merely sets in the four time intervals as desired and pushes the start switch. The sequence begins and follows through with subsidiary programs for cut-off being provided. Auxiliary circuits, such as resetting the stepping switch to start position, are not shown because they are standard circuitry with stepping switches.

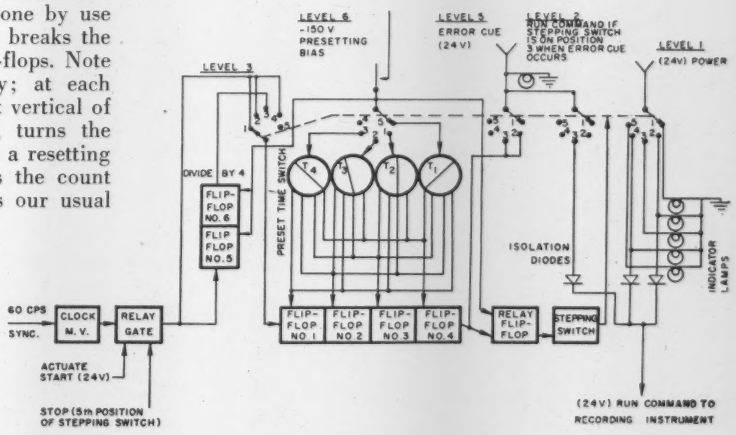


Fig. 14-7. Diagram of VIAC unit using complement-of-the-count technique.

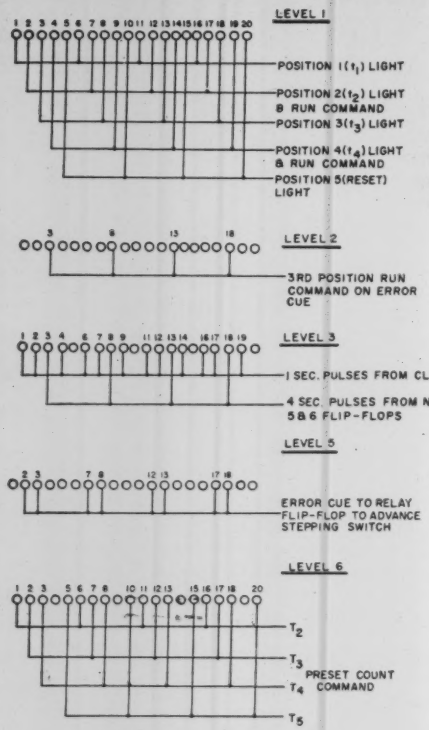


Fig. 14-8. Wiring of the five VIAC stepping-switch levels. Each 5-contact segment on each deck is repeated four times.

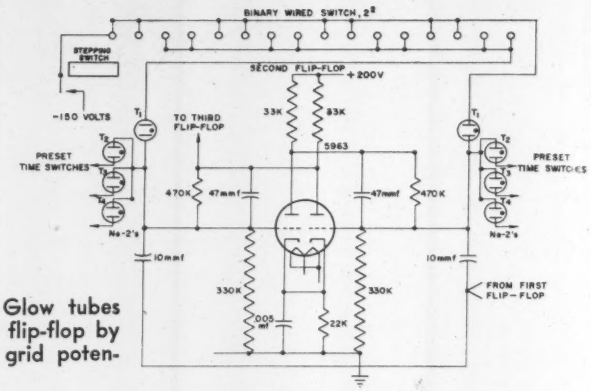


Fig. 14-9. Glow tubes T_1 preset the flip-flop by reducing the grid potential.

VIAC

The equipment described previously used preset switches to set a trunking matrix to the desired count. Although the equipment operated satisfactorily, stray pulses occasionally got through the matrix and gave a false count. Rather than build an amplitude clamp plus pulse amplifiers, another technique was used in the final controller—this was to preset the *complement* of the desired count into the counter bank and then count to the final full count. This always gave a "clean" end count. The final VIAC (variable-interval automation controller) built with this principle is shown in Fig. 14-6.

A diagram of this VIAC system is shown in Fig. 14-7. Instead of opening a relay gate and counting the time from zero to the time at which a trunking matrix line permits a pulse to activate the next timing interval (as in Fig. 14-5) the *complement* of the desired time interval is preset into a bank of flip-flops. When the relay gate is opened by the actuate start command, the bank of flip-flops starts counting from the complement count to the full count, which they can hold. The next clock pulse resets all of the flip-flops to zero, causing flip-flop 4 to activate the relay flip-flop, which switches the VIAC to the next time interval.

As in the earlier circuit (Fig. 14-5) a six level (5th level not used) stepping switch is used as a memory device so as to know which time interval comes next, and to control the recording instrument. A faster electronic stepping switch can be used if more speed is required. Fig. 14-8 shows the wiring of the stepping switch levels.

Operation of the Stepping Switch

Fig. 14-8 shows how the stepping switch routes the various signals. The first level (upper left) supplies current for contact closure of the recording device being

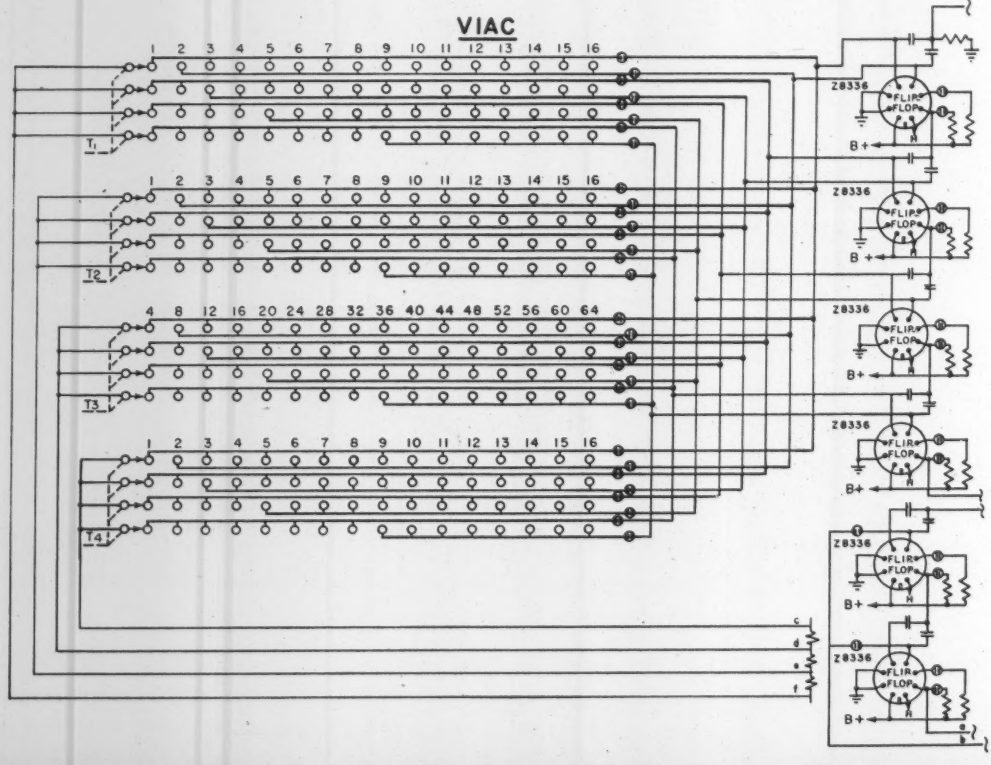


Fig. 14-10. Each binary-wired switch is connected to the flip-flop bank via glow tubes.

controlled. On the second step, which leaves the switch in the third position, the current is again shut off; in the fourth position, current is again supplied. The fifth is the rest or reset position. This follows the program required (Fig. 14-1) for control of the recording instrument. Although a 5-position stepping switch could be used, a 20-position switch is used. This requires that the basic wiring of the first five positions be repeated 4 times, as shown. When the stepping switch is in the first position, no current is supplied to the recorder.

Levels 2 and 5 of the stepping switch are used to satisfy the requirements that the unit is to proceed to interval 4 in the event an error signal arrives while the unit is in interval 2 or 3.

Position 3 on the 3rd stepping switch level disconnects the one-second pulses from the clock, and connects the output of an auxiliary bank of two flip-flops, which divides the clock rate by four, as described previously.

Stepping switch level 6 is used to route the —150-volt preset voltage, by means of appropriate wiring of the binary-wired switches (Fig. 14-10), to the side of each flip-flop which is required to be nonconducting by the complement count which is needed in the bank of flip-flops. A stepping-switch contact supplies this voltage at the right time during the period that the stepping switch is advancing so as to preset the next count into the bank of flip-flops. The divide-by-4 flip-flops are always reset to a zero count each time the stepping switch advances. Position 1 of level 6 is wired to preset time 2 since the time at which the stepping-switch coil is energized no change in position occurs. A spring return advances the stepping switch to position 2 when the stepping switch coil is deenergized. Similarly the other positions are advanced one position.

A pulse amplifier supplies the one-second pulses via the actuate relay (Fig. 14-7 relay gate) to level 3 of the stepping switch. In order to obtain clean fast action on the part of the relay which activates the stepping switch, a pilot relay is placed in the plate circuit of one half of a flip-flop. This flip-flop changes state and energizes the relay when supplied with the output pulse from the bank of four counting flip-flops. The relay flip-flop is reset by the same stepping switch relay contact which supplies the —150 volts to preset the other flip-flops. In order that the divide-by-four flip-flop pulses be supplied without loss of pulse shape, a cathode follower is used (lower left of Fig. 14-11).

Presetting the Flip-Flops

As in the earlier circuits, the preset count is set in binary-wired decimally-numbered switches, using one switch level for each bit. Fig. 14-9 shows how a flip-flop can be set to a preset state by means of a negative 150-volt signal. When the stepping switch momentarily closes a switch mounted on its armature, the —150-v signal ionizes a tiny glow tube (GE NE-2) which drops the potential of one grid of the flip-flop, causing that half to become non-conducting. The NE-2 is used as an electronic switch, which is out of the circuit except when the —150-v signal is applied. The NE-2 and grid which is activated is determined by the position of the switch. Fig. 14-10 shows how all of the binary wired switches are connected to the bank of flip-flops via NE-2 glow tubes. The lower two flip-flops are the divide-by-4 counters. The right side of Fig. 14-10 connects to the left side of Fig. 14-11 as indicated by lower-case letter or position.

Fig. 14-11 shows the control circuitry of VIAC.

Set-up and Operation

The VIAC is accurate to plus or minus one second in the first period, due to the random time at which the actuate start signal may occur. The set-up procedure and operation is as follows: determine the desired time periods, T1, T2, T3, and T4. Set these times into the VIAC preset time switches, with the instrument in the reset condition. Depress the reset button which arms the circuit so as to await the actuate pulse. Upon receipt of the actuate pulse, the VIAC will begin its sequence and furnish no output voltage in period T1. There will be a 24-volt output during T2 to actuate the recording instrument, no voltage output in T3, and 24-volt output in T4. The VIAC shuts off completely in the 5th or reset position. If error signals are present in either period T2 or T3, indexing to T4 will occur.

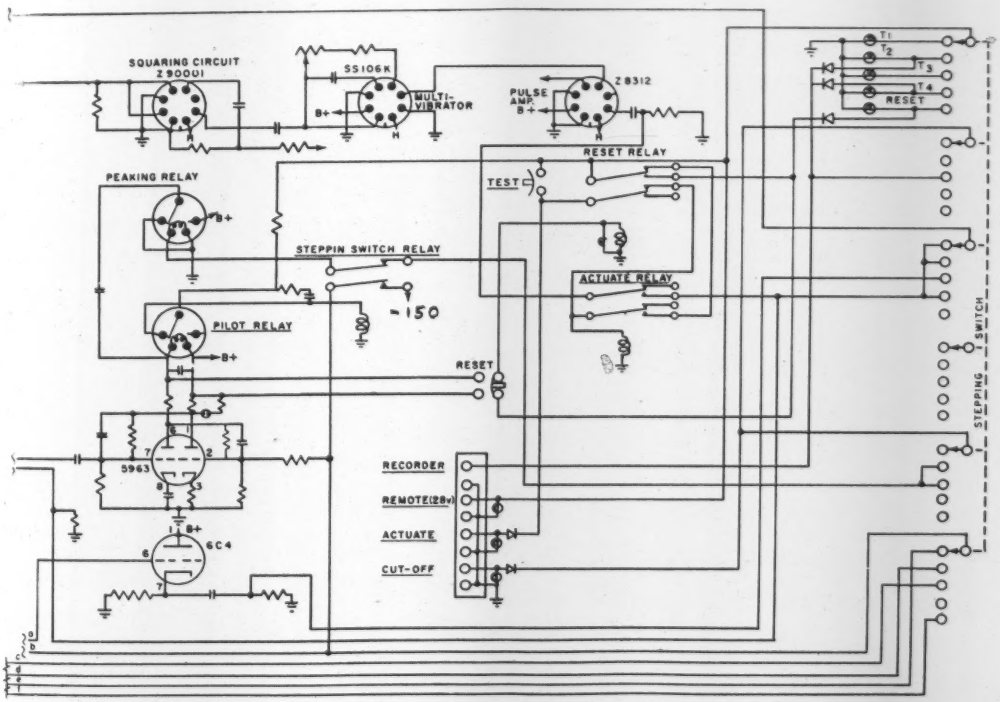
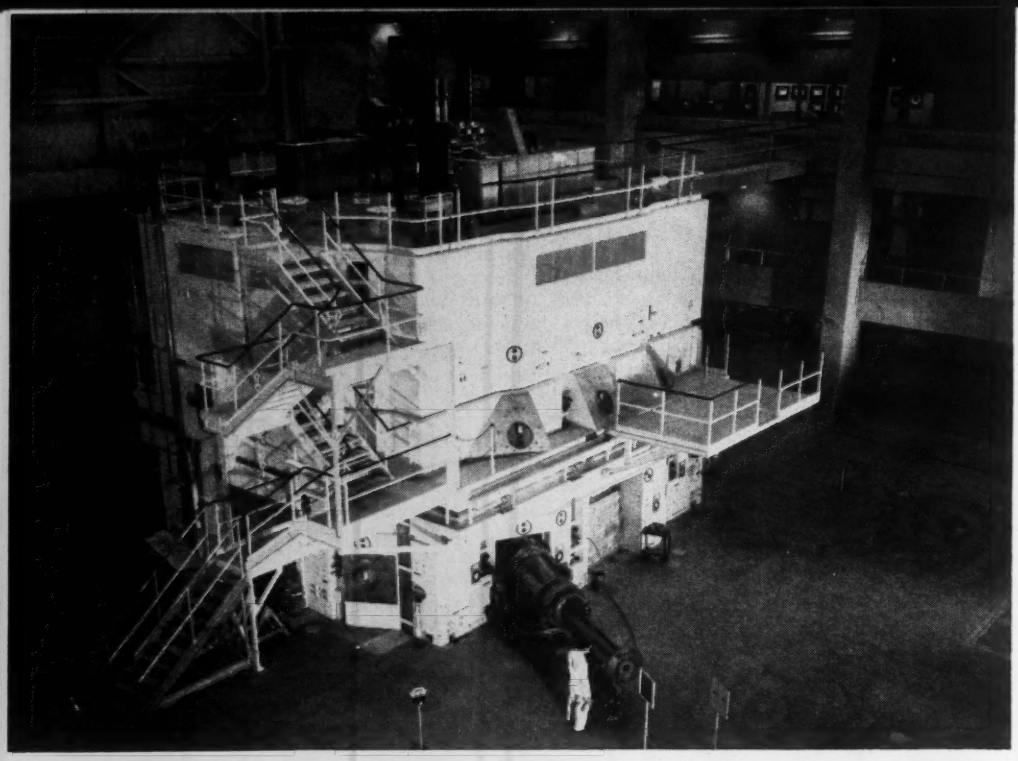


Fig. 14-11. Control circuitry of VIAC.



General view of materials testing reactor. Control room is at upper right.

The Materials Testing Reactor

E. P. EPLER

Reactor Controls Corporation

Oak Ridge National Laboratory

THE MATERIALS Testing Reactor at the National Reactor Testing Station, Idaho Falls, Idaho is operated by the Phillips Petroleum Company, Atomic Energy Division.

It was designed jointly by the Oak Ridge National Laboratory and the Argonne National Laboratory, with the instrumentation design the responsibility of the former. It became critical on March 31, 1952.

Prior to 1947, reactors were of the natural uranium graphite variety, which characteristically contained small reactivity excesses and which, therefore, were incapable of extremely rapid increases in neutron flux. Thus, the MTR became the first reactor containing highly enriched fuel which was therefore capable of extremely rapid increases in neutron flux. Because of this venture into an unexplored field of control, it was necessary to develop an entirely new concept and a new complement of instruments and devices. This work was conducted by the Physics Division of the Oak Ridge National Laboratory, and was directed by Dr. H. W. Newson, who was assisted by Dr. W. H. Jordan, Dr. P. R. Bell, Dr. Henry Straus, Dr. Stephen MacNeille, Dr. John Trimmer, and others.

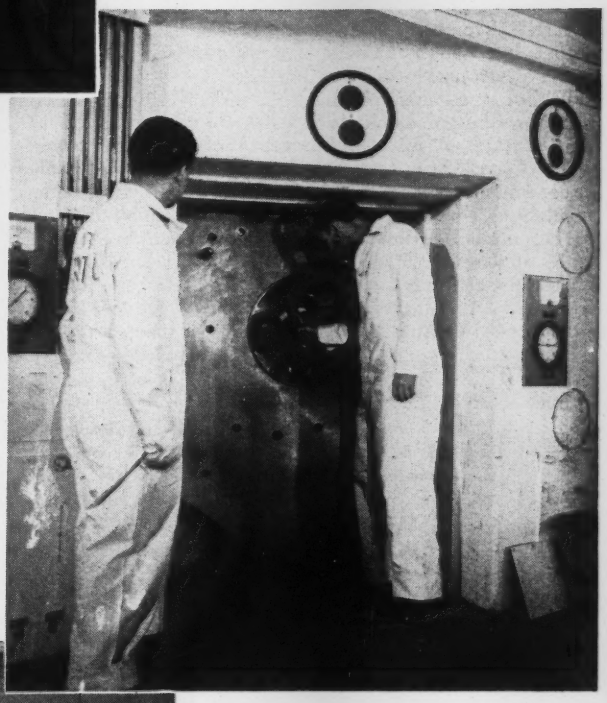
In addition to a new concept of reactor control, the following devices were developed by this group:

1. A compensated ionization chamber, logarithmic amplifier, and associated equipment, making it possible to cover a range in neutron flux of 10^6.
2. A parallel plate ionization chamber, sigma amplifier and magnet amplifier comprising a fast safety system.
3. A high performance servo system.
4. Low-level instrumentation based on the A-1 linear amplifier.

Many reactors built at the Oak Ridge National Laboratory and at other installations throughout the country have utilized these instruments with only minor modifications. At the present time most reactor control system designs offered by industry incorporate these instruments.

Considering the widespread use and the large dependence of the reactor industry on the work of these people, it is appropriate that credit be given to these pioneers.

Radiation level at end of universal coffin is checked preparatory to insertion of dummy plug into Materials Testing Reactor's horizontal beam hole No. 3.



Radiation level at the face of the Materials Testing Reactor's horizontal beam hole No. 3 is checked by using a "cutie pie."

Control room of the Materials Testing Reactor.

ELECTRONIC

CHARLES F. KEZER
Key Electric Corp.

and

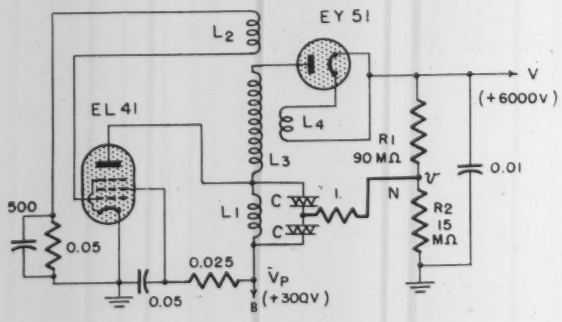
MILTON H. ARONSON
Instruments & Automation

NONLINEAR CAPACITOR REGULATES 5-KV POWER SUPPLY

Output voltage is stabilized in this circuit without increase in size or weight by using a barium-titanate capacitor as the regulating element. Circuit is a standard r-f power supply, except for the nonlinear capacitors C and the feedback between points N and C. A commercially available 7-kv oscillator coil was used. The tubes shown are European types; the EL41 may be replaced with a 6AQ5, the EY51 by a 1V2 or 1Z2, depending on the coil.

The type EL41 beam-type pentode (in a conventional tickler-coil oscillator circuit) oscillates in the low rf range. The frequency depends primarily on the resonant tank L1-C. Output developed across the plate coil L1 is fed back to the grid by the "tickler" grid coil L2. L1 is also the primary of a step-up transformer whose secondary is winding L3. The high voltage developed across L3 is rectified in the EY 51 diode, producing the 6000-volt output (no load). Filament of the diode is heated by rf power developed in the winding L4.

With the feedback between C and N disconnected, maximum output is obtained when the plate coil L1 is tuned to the self-resonant frequency of L3 by a capacitance (C) of 327 uuf. Output decreases rapidly for smaller capacitance values. This tuning effect is used to provide regulation. The nonlinear capacitors C, because of their barium-titanate dielectric, exhibit a change in capacitance of nearly 2:1 as the dc bias voltage across their plates is varied from zero to 350 v dc. Their capacitance is relatively insensitive to ac impressed voltages. One side of the nonlinear capacitors C is connected to the



+300-v dc supply B; the other terminal of each is returned via the 1-megohm decoupling resistor to a voltage *v*, derived from the voltage divider across the HV output. Voltage *v* is greater than the plate supply voltage B; the dc bias voltage across the capacitors is the difference between these voltages.

Capacitors C are chosen so that the normal operating value (the capacitance of the two in series) is well above the 327 uuf required for maximum output. Thus if the output voltage were to decrease, there would be a corresponding decrease in the voltage *v* at the voltage divider, and the bias on the capacitors C would drop; this reduced bias voltage on the capacitors lowers their capacitance, retuning the plate coil L1 toward resonance, thus tending to restore the output voltage V to its original value. If the output were to increase, the bias voltage on the capacitors C would increase, raising their capacitance and thereby reducing the output voltage V toward its original value.

The regulated supply is slightly inferior to the unregulated circuit with respect to changes in load. Regulation (percentage change) in output with respect to plate supply voltage changes, however, is improved by 2.5:1.

Output Voltage: Unregulated—5 kv no load; 4.7 kv with 20-megohm load. Regulated—4.5 kv no load; 3.7 kv with 20-megohm load.

Regulation: When unregulated, output varies from 6000 v to 4400 v when B+ varies from 300 to 400 v; when regulated, output varies from 3800 to 4200 v for B+ change of 300 to 400 v.

Source: Alfred Haas, Compagnie Francaise Thomson-Houston, Paris, France. Also *Tele-Tech and Electronic Industries*, November 1955.

GAS-DIODE MEMORY CIRCUIT

Digital computers require memory devices with two stable states—on/off, 0/1. Flip-flop circuits and magnetic cores have been used extensively.

The cold-cathode diode is a promising computer component. It requires little power, can handle large currents momentarily, is small, light, cool and inexpensive, and has normal indicator operation of over 10,000 hours. It also lends itself to visual, photoelectric, or electrical output of either polarity. However, four defects have limited its use so far—(1) only one characteristic, the maximum firing voltage, is controlled, (2) the characteristics of any one tube vary with use, (3) deionization time limits speed of operation, and (4) a continuous path is needed to maintain ionization.

The National Bureau of Standards has developed several gas-diode memory circuits with rapid access and deionization. Some circuits using these techniques might ultimately approach a cost of 10 cents per bit, compared with present cost of $1 per bit in conventional memories.

The basic diode bit circuit is simply a gas diode in series with two resistors. Power is supplied at point A. Points B and C can be connected to flip-flops, gates, etc., to make the circuit function as a memory. The basic principle is that the firing potential of a gas diode is higher than the holding potential for the tube. Hence if a voltage higher than the holding potential, but lower than the firing potential, is applied to A, the diode will not fire; B is then at A potential; C is at ground potential; tube is in *binary zero state*. Application of a positive potential at either A or B—or a negative potential at C—will now fire the tube, putting it in *binary one state*. Disadvantage of this circuit is that holding potential must be interrupted to deionize tube, and it is difficult to obtain access to one bit without disturbing others.

CIRCUITRY

The circuit is the heart of all electronics. Here are 4 more basic and interesting circuits. Unless marked, resistors are in ohms, capacitors in microfarads.

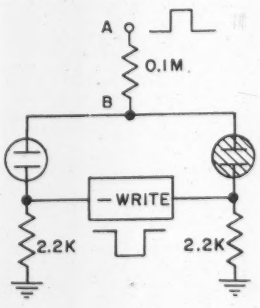
The access difficulty was attacked by changing the static bit to a "dynamic bit"—that is, using a 5-microsecond 100-volt pulse at A instead of the d-c holding potential. The pulse is repeated every 100 microseconds. This pulse will not fire a tube storing a zero; it will reionize a tube storing a one. To write a "one," it is necessary to apply a positive word pulse at B, and a negative bit pulse at C, simultaneously. As the two conditions will occur only at the intersection of selected buses, only desired bits are written as "ones." Note that a binary "one" is stored only if a tube has been fired within the last 100 microseconds.

This circuit is a one-way memory; information must be erased before new information can be read in. A second innovation was to provide a high-speed writing speed in both directions, using a double-diode bit (See next circuit).

Source: A. W. Hold and D. C. Friedman, Summary Technical Report 1918, NBS, Washington 25, D. C.

DOUBLE-GAS-DIODE MEMORY CIRCUIT

The voltage applied at A is above the firing potential; hence one diode will always be on. To write in the opposite digit, the cathode of the "off" tube is pulled down by a negative WRITE pulse, causing it to fire. This causes point B to drop to near-ground potential, so that the "on" diode starts to deionize. At end of WRITE



pulse, all current goes through the newly "on" tube; other remains "off." As the system is symmetrical, fast writing is possible in either direction—changing from one to zero or vice versa is done in 5 microseconds or less.

Source: A. W. Hold and D. C. Friedman, Summary Technical Report 1918, NBS, Washington 25, D. C.

BEAM-POWER VIDEO DRIVER AMPLIFIER

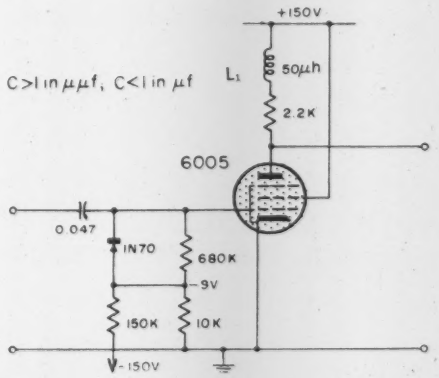
Purpose of this driver stage is to amplify positive video pulses to the level required to intensity modulate a cathode-ray tube. It is widely used in radar indicators, in applications where the higher input capacity of a triode driver (*I&A*, March, 1956) cannot be tolerated. Circuit is NBS-BuAer Preferred Circuit PC28.

A cathode-ray indicator can be intensity modulated by applying signals to either the grid or the cathode. This circuit is designed to apply negative intensifying signals to the indicator cathode. This allows the driver stage to be operated with low steady-state plate current, drawing higher plate current only during the intensifying pulses. Plate dissipation thus can be kept within safe limits, using a smaller plate load resistor (for better rise time) than can be used in drivers working into the crt grid.

Inductance L_1 provides shunt-peaking to improve rise time by a factor of 1.7 from the value of 0.12 usec that is obtained without it. Rise time without compensation (0.12 usec) is computed as

$$t_r = 2.2\ RC$$

where R = 2200 ohms and C = the total output capacity, which is composed of 7.5-uuf plate capacity, 13-uuf wiring capacitance, and 5-uuf cathode capacity of the cathode-ray tube.



Value of L_1 is computed from

$$L = mR^2C$$

where R and C have the same values as above, and m is a parameter which was chosen as 0.41. With this value of m, the rise-time improvement factor is 1.7 (to 0.07 usec) with 3% overshoot.

DC restoration is provided by the 1N70 diode in the input circuit, to bring the grid voltage to −9 v between input pulses. It can be eliminated if the duty cycle is low, with the input consisting of narrow pulses widely spaced in time.

The 6005 beam power tube is the "reliable" equivalent of the 6AQ5. Tests indicate that tube-to-tube variation of transconductance (for tubes meeting MIL specifications) will produce variations in gain of ±17%.

Input: Positive pulses, 1 to 9 v.

Input Capacity: 12.6 uuf.

Output: Negative pulses, 70 v maximum amplitude.

Voltage Gain: 7.

Rise Time: 0.07 usec.

Output Capacity: 25.5 uuf (includes 5-uuf load capacitance).

Droop: 4% for 500-usec pulse.

Source: NavAer 16-1-519, *Handbook of Preferred Circuits, Navy Aeronautical Electronic Equipment*, National Bureau of Standards, Washington, D. C.

Selection of A Control Valve

Final selection of the control valve requires consideration of all the factors discussed in this series. This résumé of these factors is based on the Recommended Practice RP 20.1 of the ISA.

C. S. BEARD

Foster Engineering Company

HOW to select the proper control valve for the given application has been the subject of innumerable articles, and recently has reached the standardizing stage in the form of a specification sheet contained in Recommended Practice RP 20.1 (Fig. 12-1) issued by the Instrument Society of America. The following discussion is based on this standard form. The ISA form is virtually identical with a specification sheet used by the author for many years. Answers to all line numbers should give a complete picture of the features of the valve selected and contain all data required for C_v calculations (see chapter 2) and valve sizing (see chapter 11).

With reference to previous chapters the author wishes to add a few notes for further clarification of each line of RP 20.1, as follows:

Refer to 1: The globe-type body is the only one of the wide variety of valve designs available which can be made double seated. It has become popular because the forces tending to close the valve are nearly equal to the forces tending to open the valve (the slight difference is caused by the necessity for constructing one seat ring larger than the other in order to remove the plug). The force required to operate double-ported valves is much less than that required for single-seated valves, except the balanced single-seated type. This latter type is an adaptation of a piston-actuated valve in which the piston is just large enough to balance the force tending to hold the valve closed; a pilot valve allows pressure to enter the chamber above the piston to balance the forces. The single-seated balanced valve should be considered when positive shutoff is required but the differential at shutoff is high.

Single-seated valves, unbalanced design, always should be considered first, particularly in sizes 2″ or smaller. This type of valve offers tight shutoff and simple construction.

In chapter 4 the possible variations of valve design with respect to flow and actuator were discussed. The type in which flow tends to open the valve normally should be employed; the effect of unbalanced forces was discussed in detail in chapter 5. Proper seating of the

CONTROL VALVE INSTRUMENTS
Specification Sheet Instructions

Prefix numbers designate line number on corresponding specification sheet.

1) Write in type of plug guiding, such as top and bottom, seat ring, top, etc.
2) If special body joint required, specify requirement, such as Ring Type Joint, Small Tonque and Groove, etc.
3) If body type other than double seated or single seated flanged head required, specify, such as Saunders Patent, butterfly and give general description.
4) Specify fluid units, i.e., GPM at F.T., SCF/H, #/Hr., etc.
5) For pneumatic spring and diaphragm state instrument output range, such as 3-15 PSI, 3-27 PSI, etc. Under other specify Springless Diaphragm, Piston, etc. Advise air pressure available for positioners, boosters, etc.
6) Other operators, i.e., hydraulic, electric motor, etc. (give details). Give operating supply such as PSI, Volts, Cycles, etc.
7) Identification of Item Number.
8) State Pipe Line Number.
9) Specify nominal body size and port size in inches.
10) Specify body form; Globe, Angle, 3-way, etc.
11) Specify body material, such as bronze, cast iron, steel, etc.
12) Specify end (line) connections; Screwed NPT, 150# RF, 300# RF, 300# RTJ, etc. Flange ratings ASA unless otherwise specified.
13) Specify type of bonnet; standard, radiating fin, plain extension, etc.
14) Write "Yes" if lubricator and/or isolating valve required.
15) Specify packing required or type of seal, such as Bellows, Diaphragm, etc.
16) If special guide required, specify type material and/or hardness.
17) For additional specifications not covered by Lines 9 through 16.
18) Specify trim material. (Trim generally includes plug, stem, seat ring (s), grease ring and packing follower. Write in any deviations on Line 22). Specify manufacturer's standard, bronze, type stainless steel, etc.
19) Specify double or single port.
20) Specify plug form; Linear, Percentage, and whether V-Port or Parabolic, etc.
21) Specify plug and seat material, if other than shown on Line 18.
22) For additional specifications not covered by Lines 18 through 21.
23) Specify conditions (PSI, Volts, Cycles, etc.), at which valve shall be "closed" and "open".
24) Specify position valve is to take on air, hydraulic, or electric failure.

Fig. 12-1. Specification Sheet of the Instrument Society of America RP 20.1, Dwg 11a.

CONTROL VALVES

SPECIFICATION SHEET

SHEET NO. _____
TAG NO. _____
DATE _____
REVISED _____
BY _____

GENERAL SPECIFICATION

BODIES

1 DOUBLE SEATED BODIES SHALL BE _____ GUIDED, SINGLE SEATED BODIES SHALL BE _____ GUIDED

2 END CONNECTIONS AS SPECIFIED BY LINE 12. BODY JOINTS SHALL BE MFGR. STD. OR _____

3 OTHER BODY FORM _____

4 FLUID UNITS: LIQUIDS IN _____ GASES IN _____ STEAM IN _____

OPERATORS

5 PNEUM.: SPRING & DIAPHRAGM _____ .SHALL FULL STROKE _____ PSI
OTHER _____
OPERATING SUPPLY IS _____ PSI

6 OTHER _____
OPERATING SUPPLY IS _____

7	TAG NO.									
8	LINE NO.									
	BODY									
9	BODY SIZE / PORT SIZE									
10	FORM									
11	MATERIAL									
12	END CONNECTIONS									
13	BONNET									
14	LUBRICATOR / ISOLATING VALVE									
15	PACKING OR SEAL									
16	SPECIAL GUIDES									
17										
	TRIM									
18	MATERIAL									
19	NO. OF PORTS									
20	PLUG FORM									
21	PLUG & SEAT MATERIAL									
22										
	ACTION									
23	CLOSE @ / OPEN @									
24	FAILURE POSITION									
25										
	POSITIONER									
26	REQUIRED									
27	BYPASS / GAUGES									
28	FOR INPUT SIGNAL OF / OUTPUT SHALL BE									
	ACCESSORIES									
29	FILTER & REGULATOR									
30	HANDWHEEL									
31										
	SERVICE CONDITIONS									
32	FLUID									
33	QTY. MIN. / QTY. MAX.									
34	QTY. NORM. @ F.T.									
35	PRESS. MAX. IN / NORM. OUT									
36	ΔP MAX. / ΔP SIZING									
37	TEMP. MAX. / NORM.									
38	SP. GR. @ 60°F / @ F.T.									
39	VISCOSITY @ F.T.									
	NOTES:									

25) For additional specifications not covered by Lines 23 and 24.
26) Specify by "Yes", or name of Manufacturer, if valve positioner required.
27) Specify by "Yes" for positioner bypass. For gauges, specify quantity.
28) On top line specify input signal band and on bottom desired corresponding positioner output band.
29) Write in if individual units or combination type desired, or if to be purchased separately.
30) Specify type of handwheel if required, such as top or side mounted, etc.,—consult manufacturer.
31) For additional specifications not shown on Lines 29 and 30.
32) Show flowing fluid; liquid, gas or steam.
33) Give minimum and maximum quantity of fluid valve is required to pass.
34) Expected normal flow at flowing temperature.
35) Maximum pressure is required for determining maximum body working pressure.
36) Show maximum ΔP and ΔP at which valve is to be sized.
37) Show maximum temperature for valve rating and normal operating temperature.
38) Show specify gravity at 60 F and at flowing temperature.
39) Show viscosity at flowing temperature.

plug on the seat requires proper guiding. Wings or skirts usually are adequate up to 100-psi pressure drop. Top-and-bottom guiding is required where high pressure-drops and high rangeability (30:1 or more) are to be met (see also chapter 3).

Refer to 2: Special types of joints will have to be determined by the piping experts in conjunction with the requirements of the process, and are to be made available simultaneously with the process flow sheets (see also chapter 3).

Refer to 3: Special bodies are described in chapter 3.

Refer to 4: Flow of gases should be given in scfh at standard conditions (atmospheric pressure and 60°F) as used in the formulae for C_v in chapter 2 (see also chapter 11).

Refer to 5: Pneumatic operators are discussed in chapter 6, where operators "other" than spring-loaded diaphragm operators also are discussed. Plant instrument air systems carry between 40 and 125 psig pressure. Pressures above 80 psig are preferred so that piston actuators can be operated from the same line. Instrument air regulators are usually limited to an inlet pressure of 250 psig.

Refer to 6: Solenoid and motor actuators are dealt with in chapter 7; electropneumatic, electrohydraulic and pneumohydraulic actuators are described in chapter 8.

Refer to 7: The instrument (tag) number in most numbering systems will include a symbol to denote the function of the instrument.

Refer to 9: Body size and line size are related. Port size is determined by the method discussed in chapter 11. If the valve size indicated by calculations is the same as the line size, either the valve is too large or the line is too small. Use of a body size larger than normally used for the calculated port size is justified under the following conditions: (1) If the plant is designed for future increase in production; (2) to reduce effect of flashing or noise; (3) to decrease velocity of flow by enlarging outlet; (4) to increase body strength; and (5) to avoid costly flanged reducers in alloy steel bodies.

Refer to 10: Selection of the valve body has been discussed at length in chapter 2. A short recapitulation may be helpful at this point.

The large majority of control applications are handled by valves whose form is loosely classified as globe type. This description applies only to the shape of the body. The plug or inner valve may vary from the conventional single- or double-seated plug or ported style to a ball or piston. The globe valve with the appropriate inner valve is the most common style of control valve in use.

Valves which obtain closure by manipulation of a rubber product include pinch, rubber sleeve, and Saunders valves. Their advantages are (1) coarse particles or sludge pass readily; (2) the effects of freezing are overcome; (3) abrasives do not injure operating parts; (4) moving parts are protected from corrosion by the line fluid, (5) they can be used in a line with serious pulsation or water hammer.

Butterfly valves are particularly advisable for (1) very large flows; (2) low-pressure-drop applications; (3) low-pressure systems; (4) economical installation.

Streamlined valves (angle or S-shaped) will (1) minimize erosion, (2) control high pressure-drops, (3) cut down possibility of cocking due to expansion of vapors at the seat, (4) afford easy changing of seats.

Slide valves, gate valves, cocks, and others find application either because of special characteristics, the possibility of converting an existing hand valve to a control valve, or individual preference.

Refer to 11: Most piping specifications for the job usually contain specifications for valve materials; deviations should be avoided or agreed to by engineers responsible for the allied equipment. Original-cost savings should not be attempted if the flowing fluid is dangerous, if replacing the valve is difficult, or if replacement would require an un-scheduled or costly shut-down. Carbon steel, cast iron, and bronze are the only materials which are considered as stock items.

Choice between iron or steel for non-corrosive service below 250 psig is not a question of strength. The trend toward steel for all hydrocarbons and steam is based upon the vulnerability of cast iron to thermal shock. Cast iron has a wide range of use for non-corrosive liquids, air or water.

Refer to 12 *through* 17: End connection (line 12) may be screwed, flanged (ASA rating is used), socket welded, or butt welded, depending on size, temperature and pressure rating. The chapter on mechanical features (chapter 4) discussed variations of connections, the bonnet (line 13), lubricator and isolating valve (line 14), packing (line 15), and special guides (line 16).

Refer to 18: Stainless steel is used extensively to minimize erosion as well as on corrosive service. AISI types 304 or 316 are used for parts which are not hardened. Hardened parts may be made from one of the stainless steels in the 440 series. Stellite facing is recommended for highly erosive service in which hardening is not adequate. Bronze trim is used for many water applications.

Refer to 20, 21, *and* 22: Flow characteristics (which depend on the shape of the inner valve) of most styles of valves have been discussed in chapter 3. With the wide variety of flow/lift characteristics that are available, and the variations which may be obtained by shaping plugs and ports, a flow characteristic that complements the controller characteristic to obtain linear over-all control characteristics can be obtained. However, in order to tailor the valve characteristic to the process, it is necessary to analyze the process behavior. Use of the analog computer eventually will make this possible.

The *quick-opening* (poppet) or beveled-disc inner valve should be considered when: (1) control can be obtained by simple on-off valve action; (2) maximum valve capacity must be obtained rapidly; (3) the process has short time lags—such as in many pressure, flow or level control situations, or temperature control accomplished by mixing fluids of different temperatures; (4) the sensitivity obtained by long valve travel is not necessary; (5) bad sludge conditions exist.

Use of the *linear-characteristic* valve (having a shaped plug or rectangular ports) is indicated when: (1) a large percentage (more than 40%) of the system pressure drop will occur across the control valve; (2) high rangeability is not required—this will occur if the supply pressure to the valve and discharge pressure from the valve are stable; (3) the process has short time lags or, in other words, the valve lag is predominant; (4) the system may be controlled with a proportional band setting of less than 10% on the controller; (5) it is evident that the major changes in the process are linear or are load changes; (6) the flowing fluid carries solid particles or is scale forming.

Advantages of the use of a *modified linear characteristic* (often described as "parabolic plug" or "V-port") inner valve are discussed in chapter 3 and include con-

Nomenclature

1. Valve Body Assembly
2. Double Seated Valve Body
3. Seat Ring
4. Valve Plug
5. Valve Plug Stem
6. Valve Plug Guide
7. Guide Bushing
8. Bonnet Assembly
9. Stuffing Box Packing Assembly
10. Packing Material
11. Radiation Fins
12. Lubricator
13. Packing Nut or Flange
14. Packing Follower
15. Packing
16. Lubricant Ring
17. Blind Head
18. Diaphragm Actuator
19. Diaphragm Case
20. Diaphragm
21. Diaphragm Plate
22. Diaphragm Spring
23. Stem Extension
24. Yoke
25. Spring Adjuster
26. Spring Seat
27. Travel Indicator
28. Travel Indicator Scale

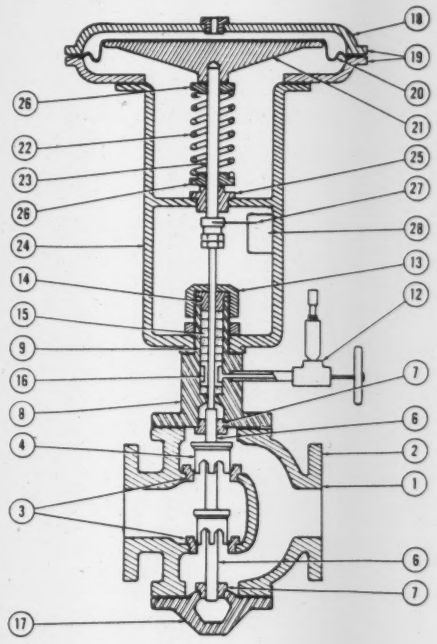


Fig. 12-2. Basic elements of a control valve. This nomenclature was used by the Subcommittee on Control Valve Terminology (of the ASME:IRD Terminology Committee) before the September 1956 meeting of this subcommittee, at which meeting certain changes were made which have not yet been officially published.

ditions where good control at low flows is desired and low rangeability is required.

Use of a control valve with an *equal-percentage* (logarithmic) flow characteristic (obtained by a shaped V-port or parabolic plug) is indicated when: (1) load changes will not vary more than 10 to 1, but rangeability requirement may be high; (2) friction losses in the system in series with the control valve approach the pressure-drop available across the valve; (3) the pressure differential available across the control valve cannot be predicted but will probably vary widely; (4) operating conditions are so undetermined that the possibility of good control is increased by use of this characteristic.

Refer to 23: The action (air-to-open or air-to-close) depends on the process requirements. Detailed information should be added on line 25.

Refer to 24: Selection of the position a valve assumes upon air failure also depends on the process. Reversibility of valve and controller allow for field or shop changes.

Refer to 26, 27, 28: Positioners for diaphragm actuators and cylinder actuators were discussed in chapters 9 and 10, respectively. They become necessary to insure sensitive control for (1) high pressure-drops across valve; (2) control with wide throttling range and large characterized-port valves; (4) high-pressure applications; (5) sludge and suspended-solids conditions; (6) amplification of the standard 3-to-15-psig signal; (7) split-range operation; (8) reversed valve operation; (9) increased speed of operation; (10) positioning of cylinder or springless actuators.

Refer to 31: Additional accessories to be added on line 31 may include boosters, valve position locks, position indicators, etc.

Refer to 32: Use of data on service conditions has been discussed in chapters 2 and 11. As previously stated, correct operating data are vital to correct sizing as well as to the selection of the style of valve to be used.

The importance of an accurate statement of the fluid flowing through the valve cannot be over-emphasized when dealing with fluids which offer complications. These complications may be due to corrosiveness, toxicity, or any particular physical or chemical characteristic. The strict requirements in determination of wall thickness, flange dimensions, and dimensions of points of critical stress account for the reliability of most published pressure-temperature ratings.

Maximum allowable pressure-drop which can be applied to the valve is approximated by the following equation:

$$\Delta P_{max} = A_D \times P_E / A_V$$

where: ΔP_{max} is the maximum pressure differential against which valve must close; A_D is the useful effective area of diaphragm in the actuator; P_E is the excess pressure (above the pressure required to position the spring) which may be allowed to overcome unbalance; A_V is the area of flow opening through valve seat.

Balanced valves commonly require 1.5 to 3 psi excess pressure. Unbalanced types require between 4 and 12.5 psi, depending on controller output, supply pressure, and type of control.

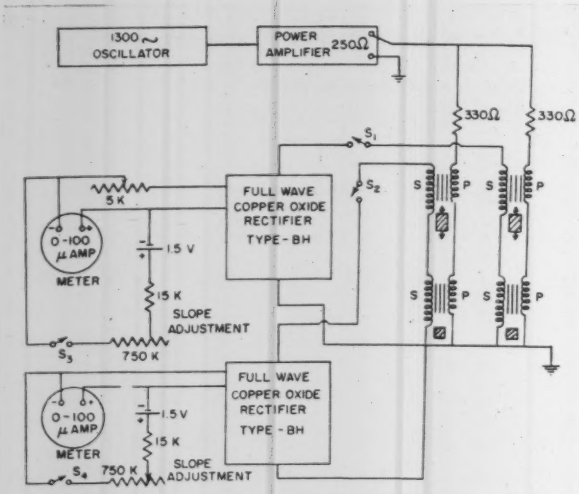


Fig. 1. Elements of the film thickness gage. Diff-tran pickups at right (one pair for each end of bearing) are excited by 1300-cps signal. Outputs are rectified and indicated conventionally.

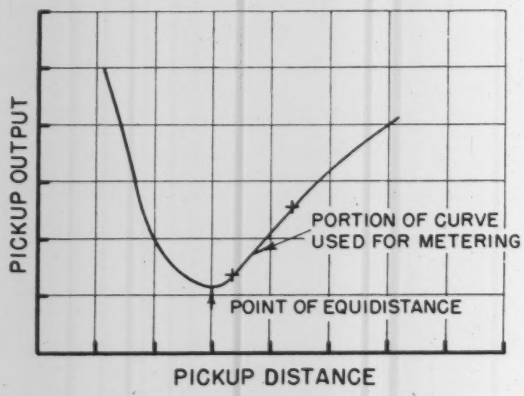


Fig. 2. Response characteristic of pickup.

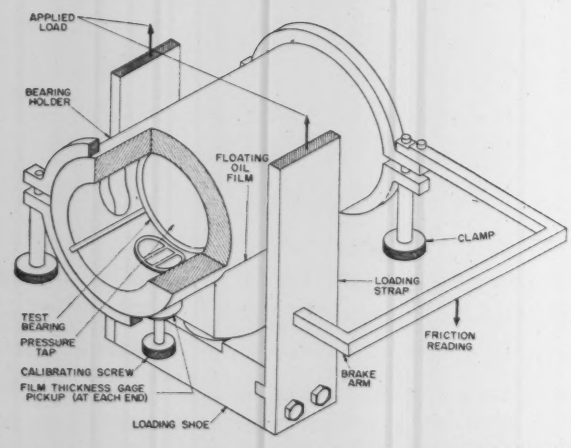


Fig. 3. Bearing holder and test bearing with film-thickness-gage pickup.

Measurement of

W. E. MEYER[1], M. B. PURVIS[2], and F. J. VILLFORTH, JR.[3]

OBSERVATIONS on lubricant films have been reported in the literature constantly since Reynolds postulated a theory of performance in 1886. Measurements are necessary for the advancement of knowledge in the field of lubrication because an exact solution of the differential equations describing the lubrication phenomena is not possible. One major stumbling block in this field is the extreme sensitivity required of the instrumentation.

This paper describes instrumentation developed at The Pennsylvania State University in co-operation with The Texas Company for making such observations.

Requirements of a Film-Thickness Gage

Various investigators have measured film thicknesses. Barber and Davenport[2], Dubois and Ocvirk[3] and others used *dial indicators*. Clayton and Jakeman[4] devised an *optical method* of high sensitivity but obtained negative film thickness indications under conditions under which penetration of the journal into the bearing could not actually have occurred. Simons[5], Allen[6], and Kollmann and Hockel[7] employed *capacitance methods* of various types. Greenough[8] reports on an instrument of the *mutual inductance type* developed by the National Bureau of Standards. Stone[9] describes a journal position indicator employing *differential transformers*.

As film thickness was to be measured when the bearing is lubricated with grease or other non-Newtonian fluid, it was necessary to use an instrument which would neither require mechanical contact between shaft and bearing nor be sensitive to the medium in the space between shaft and pickup face. As a journal position indicator based on Stone's design was available which inherently satisfied these requirements, it was expedient to convert it into a film-thickness gage.

The Stone instrument proved to be inaccurate at the required level of sensitivity for this application because temperature-induced variations in the zero calibration proved to be of the same order of magnitude as the film thickness. By converting to a film-thickness gage the distortions due to temperature gradients were eliminated, and the required data could be obtained.

Gage Circuits and Mounting

The gage (Fig. 1) is an a-c instrument whose output is passed through a simple rectifier (without phase discrimination) to a d-c indicator. A 1300-cps oscillator drives the primaries of two pairs of transformers; one pair for each side of the bearing. The indicator indicates

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[2] Assistant Professor, Department of Mechanical Engineering, The Pennsylvania State University. Present address: Bell Telephone Laboratories, Inc., Whippany, N. J.
[3] Project Leader, Beacon Laboratories, The Texas Company, Beacon, New York.

Bearing Lubricant Films

A differential-transformer gage has been developed for determining bearing lubricant film thickness to less than 0.0001 inch. Hydraulic flotation of the bearing assembly is used. The bearing test setup and instrumentation are described for making readings of film thickness, temperature, and pressure at any angular position.

the unbalance between the secondaries of a pair of transformers. One of the transformers on each side (the dummy) has a fixed gap; the other (the active element) has a variable gap between the transformer core and a laminated section which is an integral part of the test journal.

The unbalance between the outputs of the secondaries of the two transformers is a function of the distance of the active transformer (or pickup) from the journal, as shown in Fig. 2. The working range of the gap is the nearly linear portion of the response curve. Even with large gaps between pickup and journal it is possible to operate the instrument without amplification by driving the transformers at a high level.

The pickups are inserted through adjustable mounts into a sturdy steel sleeve which serves as a bearing holder (Fig. 3). The bearing is shrunk into this holder and precision bored after installation. The cylindrical bearing holder is floated on an oil cushion through which the load is applied to the bearing. This permits measuring the bearing friction by arms attached to the bearing holder and resting on a scale—allowing the holder to be rotated for measuring film thickness, pressure and temperature at any position.

Calibrating Procedures

The film-thickness gage is calibrated by placing the bearing and journal in contact so that the line of contact passes through the center of the pickup faces. Each pickup is then moved in its mount away from the journal, the motion being accurately measured by means of a Sheffield Plunjet pneumatic gage with an amplification of 5000 x.

The oscillator output and the air gap of the dummy transformer are so adjusted that 1-division deflection of the d-c meter corresponds to 0.0001″ pickup displacement. Pickup position can then be estimated to 0.00002″. No difficulty has been experienced in selecting adjustments which give linear response throughout the range of film thicknesses occurring during operation. After calibration the pickups are locked into position.

The reliability of the calibration depends on: (1) the ratio of transformer primary to secondary voltage at a given air gap, (2) the primary voltage (or oscillator output), and (3) the change of the pickup air gap with operating conditions (for a constant lubrication film thickness).

These influences can modify both the rate-of-response and the zero reading (condition of zero film thickness). However, experience as well as systematic studies have shown that rate of response remains sufficiently constant for the amplification used so that only periodic checks are needed to guard against errors due to aging of electronic components, etc.

Establishment of Zero Point

The zero reading, however, must be verified frequently because it was found impractical to provide automatic compensation for all factors influencing it; operating procedure is to verify the zero reading prior to every film thickness measurement.

There are four influences on the zero reading: (1) The variation of the zero reading with angular shaft position, (2) the bending deflection of the journal, (3) penetration of the journal into the bearing surface due to elastic deformation, and (4) variation in resistance characteristics of the pickups with operating temperature.

When observed film thicknesses are greater than 0.001″, these influences can be regarded as negligible. However, due to the thin films achieved with grease lubrication, precautions to include the effects of the above quantities were taken.

Despite efforts to achieve a perfectly uniform magnetic flux through the journal laminations, a measurable deviation in the response did exist. The variation was of the order of 0.00002″ for 180° of shaft rotation. To eliminate this influence, a careful plot of the response reading vs angular shaft position was made. The curve was planimetered and the mean deviation determined. The reference point on the journal was then chosen at the point of this mean deviation and the meter zeroed for that angular position. Thus, due to the damping characteristics of the metering circuit, the influence of the magnetic variations was eliminated.

The bending deflection of the journal has been measured by dial indicators and found to be 0.0002″ from the bearing center to the edge for a load of 780 psi projected bearing area. As the film-thickness gage is zeroed for the operating load, this bending deflection curve in operation is the same as that measured statically. This bending deflection was measured on the top surface of the journal while the load was applied from below so that the penetration of the bearing by the journal would not be a factor in the reading. A second set of readings was made by the film-thickness gage to determine the variation in the zero reading with the operating load. This test was made to determine the relative magnitude of the penetration of the journal into the bearing surface, because the measurement should include the penetration as well as the bending deflection. It was found in this manner that there was no significant penetration of the bearing by the journal—the total variation of the zero reading with load could be accounted for by the bending deflection. There is, therefore, no correction necessary for penetration over the range of loads used in these tests.

When the equipment is operated at elevated temperatures for extended periods, the pickups are heated by

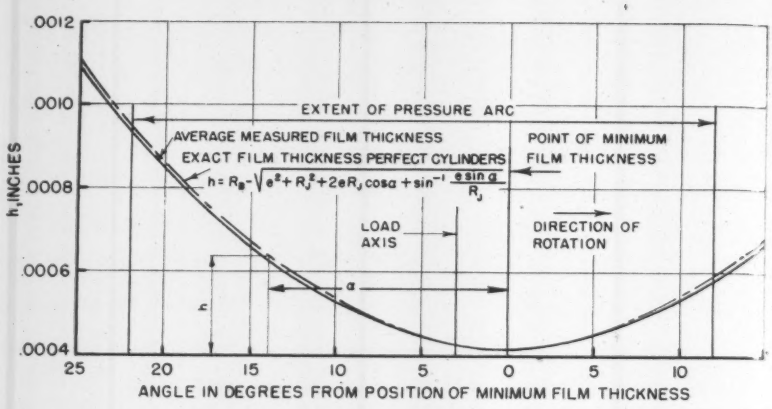

Fig. 4. Comparison of experimentally determined film thickness with exact geometric clearance.

conduction through the bearing holder. This heating affects the pickup's resistance characteristics and causes a zero shift of the order of 0.001″ for a 200 F degree temperature rise. Accordingly, the apparatus is brought to equilibrium at the desired journal speed, load, lubricant feed rate, etc. The journal is then stopped, set at the reference position, placed under the operating load, and the film-thickness-gage zero is set. The operation is then resumed and film-thickness readings taken directly at any desired angular position.

Results

Fig. 4 shows typical test data and indicates the sensitivity achieved. The measured height of the clearance space at different angular positions is compared with that obtained by calculation.

The measured values represent the mean of the indications of the two pickups on either side of the bearing. The individual indications differ from each other in some cases more than their means differ from the theoretical values. This is due to the imperfections of bearing and shaft. However, it is necessary at the present state of the art to deal with perfectly cylindrical shapes in the analysis of the results.

It should be noted that after zeroing, the bearing position with respect to the shaft is adjusted to give equal readings at both sides of the bearing for the condition of minimum film thickness. In this manner the influence of any imperfections in geometry, which are minor to begin with if precision parts are used, is held to a minimum.

The expression for the height of clearance space requires knowledge of the bearing and journal radii. In order to define these radii with adequate accuracy their dimensions were determined statically as a function of temperature. This was made possible by circulating heated oil through internal passages in shaft and bearing. Several thermocouples in the bearing and journal gave readings which were averaged in order to determine the diameter variations with temperature. Fig. 4 shows that this method gives acceptable results despite the fact that the temperature distributions during the static tests and during operation differ somewhat from each other.

Additional Instrumentation

Aside from the film-thickness gage, the instrumentation includes numerous thermocouples, some of which are installed 1/16″ below the bearing surface, others in insulated plugs so that their junction is in direct contact with the lubricant film. The couples in the shaft are brought out through copper slip-rings and brushes.

Provisions are made for obtaining film pressures at three positions along one axial plane of the bearing. With oil lubrication such pressures can be determined by instruments located at some distance from the bearing, but with greases special steps must be taken to insure accurate readings if these are to be taken rapidly. In the present application, piezoelectric pickups were installed in the bearing holder in such a manner that their active faces are in close proximity to the bearing surface. The electrostatic charge developed by the pickups is indicated directly on dial instruments. The pickups are temperature compensated and will retain a charge so well that static pressure measurements can be made with them without difficulty provided that care is taken to avoid leakage of the electrostatic charge anywhere in the circuit.

As the bearing may be rotated to any angular position with respect to the load axis, temperature and pressure traverses may be made readily during operation. It is, of course, necessary to give the system time to re-establish equilibrium after every change of the angular position of the bearing. The relatively large clearances (of the order of 0.005 inch/inch of diameter) give a relatively short active film arc and, therefore, there is no influence on the bearing performance due to the changing location of the lubricant inlet with respect to the load axis. This instrumentation has proven to be satisfactory within the range of operating variables.

Acknowledgments

The authors wish to express their appreciation to W. P. Kistler, J. L. Lorenz and F. H. Yonker for valuable contributions in the development of the several instruments.

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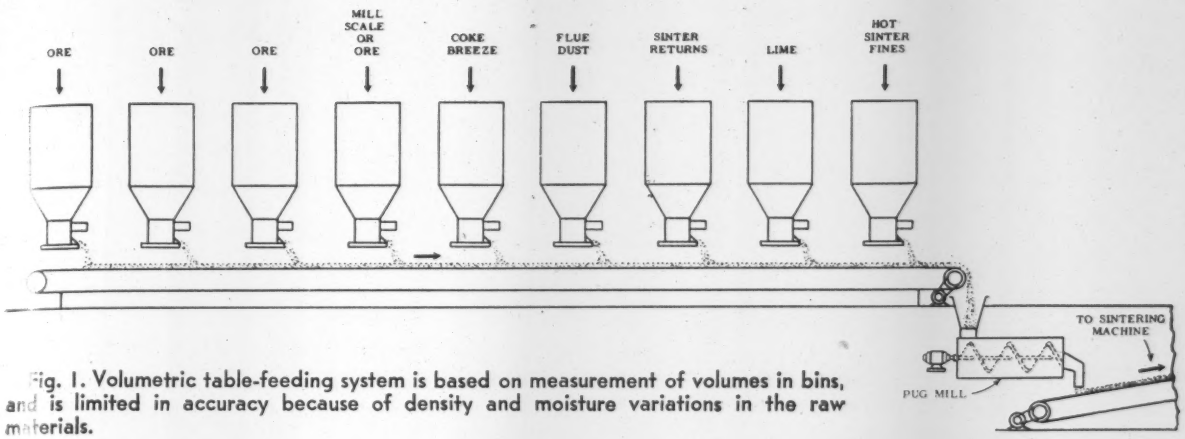


Fig. 1. Volumetric table-feeding system is based on measurement of volumes in bins, and is limited in accuracy because of density and moisture variations in the raw materials.

Sinter Plant Control

Advantages of charging sinter to the blast furnace are such that major steel companies are considering 100%-sinter operation. This makes sinter-plant control an important problem. Gravimetric blending of the sinter components is the most accurate technique. Moisture measurement is a serious problem.

T. R. ZATKOVICH and **B. E. HAMLETT**
Builders-Providence, Inc.

SINTERING, or agglomeration, of iron is the fusing of flue dust, filter cake, and iron-ore fines into a solid mass that can be fed to the blast furnace in chunks of such size that they are not blown out of the furnace.

In steel mills this is done by igniting a blend of flue dust, iron-ore fines, filter cake, coke breeze or some other fuel, mill scale, sinter returns, and lime, and drawing air through the bed to support the burning. Fuel is provided to only partially melt ingredients into a sticky mass, and then the sinter is allowed to cool and solidify. It then is crushed and screened and sent to the blast furnace for use.

Up to a few years ago the sinter plant played a minor role in our steel mills, owing its existence mainly to the need for using the ore fines and flue dust accumulated as a result of screening and air pollution controls. However, developments in the past three to four years have tended to change this picture, greater and greater attention is being focused on sinter-plant operations.

A reason for this change of thinking can be traced to the influence of English and European steel makers who, having to contend with low-grade-ore supplies, have made many advances to the art of making and utilizing sinter.

One major economic reason for the increased interest in sinter is the results obtained from recent tests by both the English steel industry and the United States Steel Corporation (at their Gary Works), wherein they charged 100% sinter to the blast furnace. The results from the tests are as follows: (1) 20% saving in coke/ton of iron, (2) 40% reduction in flue dust produced, and (3) 14% increase in the iron produced/sq ft of hearth area.

From these figures you can see why many major steel companies are seriously considering putting all their blast furnaces on 100%-sinter operation.

This new emphasis on sinter production has prompted increased research activity to determine how to make improved sinter. The logical place to begin the control of any end product is with the original components which go into its makeup.

Volumetric Blending System

The sinter mix which is fed to the sinter machine is composed of a blend of various grades of iron ore fines, mill scale, coke breeze, flue dust, sized sinter returns, lime, hot sinter returns, and filter cake.

Most existing sinter plants have blended these materials on a volumetric basis, utilizing table feeders such as shown in Fig. 1. Table feeders have proved to be dependable feeders for these materials whose moisture content is often high, making them difficult to feed by other means. Some plants have installed d-c motor drives on their table feeders so that they might speed up or slow down the blend rate remotely from the sinter-machine control panel. Even with d-c drives, however, this system is basically volumetric and subjected to the inaccuracies resulting from handling materials which vary widely in bulk density and moisture content.

Presented at Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, 1956.

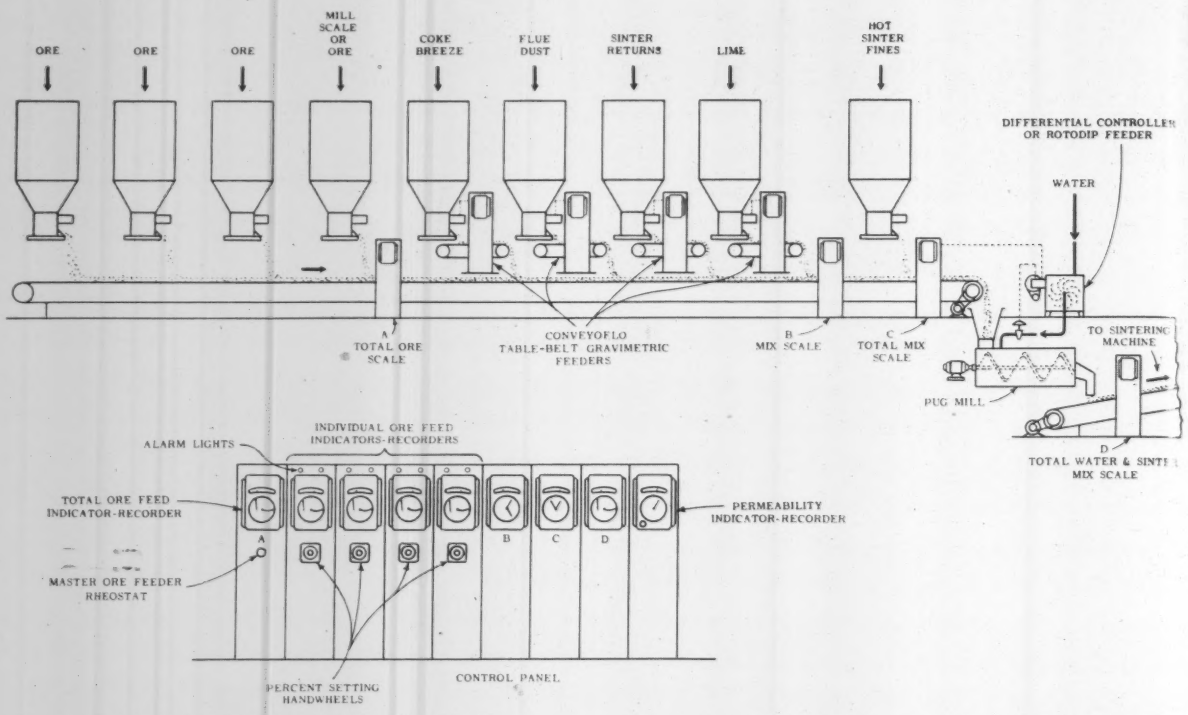


Fig. 2. Gravimetric blending is based on weight measurement. Total ore scale (A) establishes a master signal proportional to the weight of ore, which controls the individual "Conveyoflo" feeders. Hot sinter fines are added at end of belt to prevent hot fines from coming in contact with the belt. Individual percent-setting handwheels at control panel (bottom) permits individual adjustment of components.

Nature of Materials

Before attempting to adapt any type of a gravimetric blending system to sinter-plant operations, it is necessary to understand the nature of the materials to be fed. First of all, the ore fines are subject to severe changes in moisture content and, therefore, their feed, even with a table feeder, is unpredictable.

The other materials, such as mill scale, coke breeze, and flue dust are all subject to the same feeding difficulties to a greater or lesser degree.

It is possible that future developments will show that it is feasible to draw the coke breeze and flue dust directly from the bin with belt-type gravimetric feeders.

Hot sinter-fine returns are troublesome to control because (1) the rate at which they are produced cannot be predicted, and (2) the high temperature of these fines prevents their being brought into direct contact with the rubber collector belt.

Gravimetric Blending System

With these facts in mind, let us design a gravimetric blending and control system for these materials.

First, it has been determined that certain materials such as coke breeze and flue dust play a more important part than others in the blend; therefore, these materials should have individual gravimetric controls.

As the ore is difficult to feed uniformly, it is possible to feed the ore from four or more bins, allowing them to feed at uncontrolled rate, and then weigh the total ore discharged (along with the mill scale) by means of a "Conveyoflo" belt scale. This scale is equipped with a transmitter to send a controlling signal to all the feeders downstream so as to assure a uniform blend at all times. The materials downstream (such as coke breeze, flue dust, sized returns, etc.) are fed with table-belt gravimetric feeders. As mentioned previously, although there is a possibility that these materials could be withdrawn directly from the bin with the conveyor belt, the more time-proved table feeder has been used as a better guarantee of getting the material from the bin under all conditions.

This table-belt gravimetric feeder consists of a table feeder discharging onto a "Conveyoflo" belt feeder which contains a pneumatic controller for feedback control to the d-c motor driving the table feeder. The set point of this controller is positioned in accord with the signal from the total ore scale. The operator can change the percent setting of any component going into the blend from the master control panel.

Control Panel

The master control panel (Fig. 2) is equipped with an indicator-recorder for total ore feed, plus individual indicator-recorders and percent-setting handwheels for each material being fed. The operator is able to manually position the rheostat controlling the ore and mill scale feeders to obtain any desired feed rate; as the other materials are automatically increased or decreased proportionally, the blend is always correct.

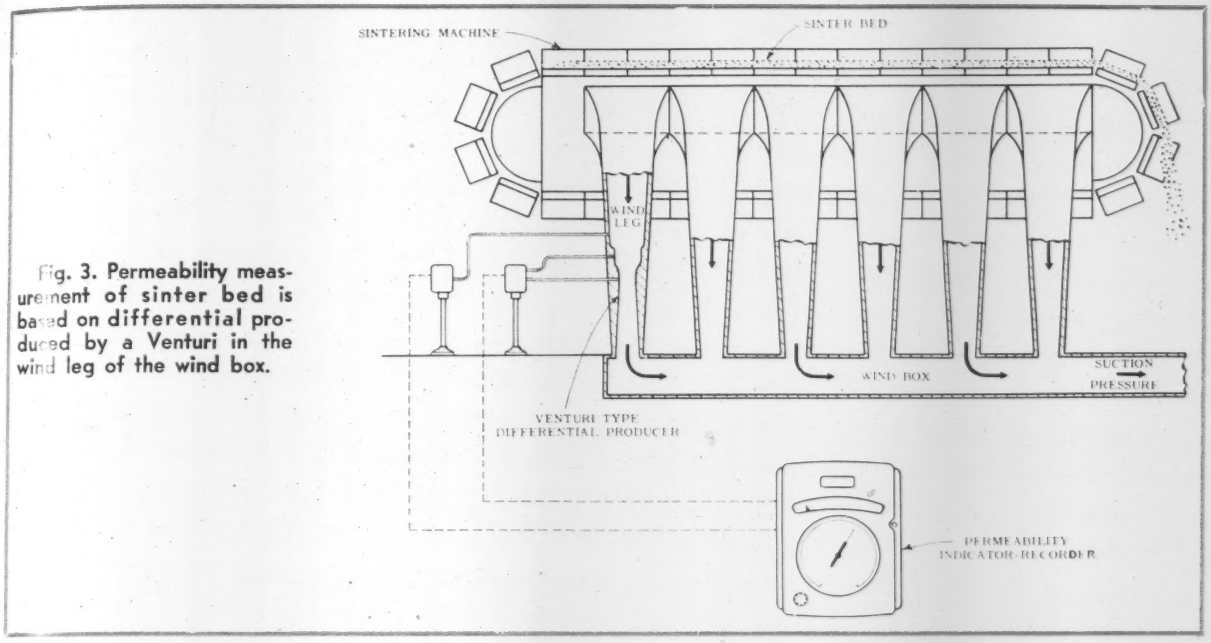


Fig. 3. Permeability measurement of sinter bed is based on differential produced by a Venturi in the wind leg of the wind box.

Mixing Sequence

The logical place to feed the hot sinter-return fines is after the mill scale feeder and before the total ore scale, because here the hot fines could be fed on top of the ore and scale and then weighed. However, design limitations of the sinter plant make it desirable to locate the hot-fines bin near the end of the blending line where the fines could fall into the bin by gravity from the discharge of the sinter machine. Therefore, it was decided to adopt a system whereby we would weigh the mix up to that point, add the hot fines with a table feeder, and then weigh the total. The readings from both scales feed into a differential summator which directly indicates the rate of hot-sinter-fine feed.

Moisture Control

A major problem in the preparation of sinter mix is moisture control. Control of moisture by direct measurement has not been possible to date. Although the moisture content of the sinter mix ingredients varies, this variation occurs over a reasonable length of time and can be traced as a trend.

To follow this trend, a signal is taken from the total-sinter-mix scale to control the addition of water to the mix mill. The water can be added by means of a gravity feed "Rotodip" feeder or by means of a differential water controller.

Another indirect approach to moisture control is by measurement of the permeability of the sinter bed. Some research and sinter-plant men feel that there is a relation between permeability and moisture content. The permeability is a measure of the porosity of the bed, and is a function of bed depth, air flow, and suction pressure. The usual measurement of permeability is accomplished as shown in Fig. 3. A Venturi-type primary element is installed in a windleg. A signal is transmitted from it and from a suction-pressure transmitter to a permeability indicator-recorder. A temperature compensation is usually not required because the windbox chosen for air flow and pressure measurement is in a zone where ignition of the bed is complete and temperature is uniform. The true value of the permeability meter in controlling sinter quality is still to be determined; indications are that most of the newer sinter plants will incorporate one or more in their design.

In addition to control of the sinter mix blend, it is important for the sinter-plant superintendent to know and have records of the incoming stocks of ore, flue dust, etc., and also the total output of finished sinter. This is accomplished with a "Conveyoflo" null-balance-type belt scale which results in a compact installation. This scale incorporates a return belt weighing system which compensates for difference in belt thickness and weight by weighing both the carrying and return idlers.

The difference between these two weights, or the effective load, is detected by a pneumatic null-balance diaphragm which matches any change in loading by increasing or decreasing the air pressure necessary to balance this load. As the scale requires no deflection in the belt, it can be installed even at points of high belt tension.

Calibration of the weighing scales and control scales can be made with *known loads*, *test chains*, or *dead weights*. Of these three the known-load method is preferred because it duplicates actual load conditions. In cases where it is not possible to run a known load across the scale, satisfactory calibration can be made by means of test chains of known weight per foot. The least preferred method is the dead-weight method because it does not duplicate the actual loading conditions of the belt, but only imposes an external force on the weigh spans.

Within the next two to three years, eighteen or twenty new sinter plants are scheduled to be built. Each of these plants will include new means of control because developments in ore feed, direct moisture-measurement, etc., are still to be made; much work remains to be done to bring automation to the sinter plant.

The basic control system as outlined was developed in cooperation with the Research Division of United States Steel, and is now being installed at the new Fairless Works Sinter Plant.

DYNAMIC BALANCING

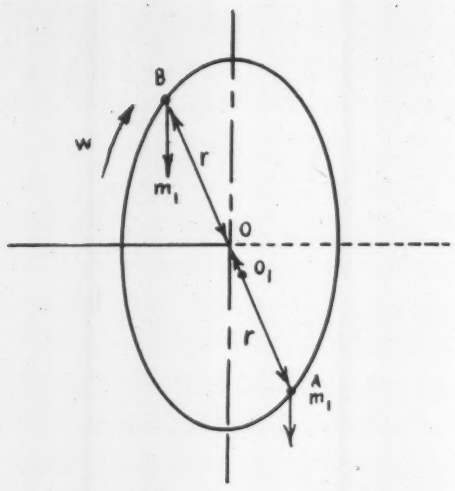


Fig. 1. Two-dimensional flat disc is easily balanced statically by attaching a weight diametrically opposite from the unbalanced mass.

Unbalance in a three-dimensional object can be eliminated by the application of balancing weights in two different planes. Electronic techniques make it possible to establish the amount and position of the balancing forces.

S. A. RYBB
Dawe Instruments, Ltd.

HIGH SPEED of rotation of modern machinery requires high accuracy in dynamic balancing. There are two types of unbalance—static and dynamic. Although they can occur separately, they usually take place together. *Static unbalance* moves the center of gravity of the body away from its geometric center, tending to make the body rotate about its center of gravity instead of its geometric center; *dynamic unbalance* produces a tendency for the body to revolve about an axis not coincident with its natural axis of rotation. In both, the unbalance forces are proportional to the *square* of the angular speed, emphasizing the need of correct balancing in machines operating at high speeds.

Balancing a Flat Disc

Fig. 1 shows a circular lamina rotating at an angular speed ω about an axis perpendicular to it and passing through its geometric center. If its weight is uniformly distributed, its center of gravity will coincide with its geometric center and it will be perfectly balanced.

If we have an out-of-balance weight at A, of mass m_1, the center of gravity of the lamina will move to O_1, and the system becomes unbalanced. A centrifugal force proportional to the out-of-balance mass and the square of the angular speed now acts at point A.

To balance such a disc, all that is necessary is to add a similar mass m_1 at B, in diametrically opposite position; then the forces and bending moments can be shown to be in perfect equilibrium.

However, there is no such thing as a disc of negligible thickness, although flywheels and grinding wheels usually can be brought to a satisfactory state of balance in this manner. For non-planar bodies the situation is much more difficult.

Balancing a Three-Dimensional Body

Let us consider a shaft (Fig. 2) made of perfectly homogeneous material, rotating about an axis XX at an angular speed ω. As the material is homogeneous, there are no out-of-balance forces acting and the rotor's center of gravity coincides with its geometric center along the axis XX. The system is in perfect equilibrium.

If a mass m_1 is attached at A, the center of gravity will move from 0 to 0_1, causing static unbalance. A mass m_2 attached in a plane further along the body at B will bring the center of gravity back to the point O, thus restoring the *static balance*. However, there will be a small bending moment tending to distort the body even when stationary. When the shaft starts to rotate, this bending moment will be overshadowed by the large centrifugal forces generated, and the body will tend to rotate about the axis YY rather than its natural axis XX.

The forces acting on the body and indicated by the arrows are, in fact, instantaneous forces whose direction change as the body revolves. The forces applied to the bearings are thus cyclical and in phase with the rotation. As the angular speed of the body varies, so will the periodicity of the forces applied to the bearings. This variation of periodicity is particularly dangerous because it can excite components which have a natural frequency within the range covered, leading to violent reactions.

To restore equilibrium it is necessary to apply a *couple* at a diametrically opposite position, and of such magni-

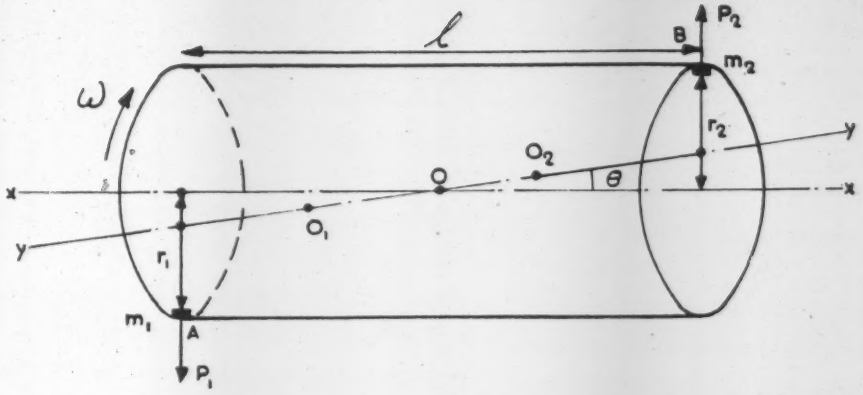


Fig. 2. Unbalanced mass m_1 (attached at point A) causes center of gravity to move from 0 to 0_1. Mass m_2 restores static balance but not dynamic balance; body will tend to rotate about axis yy rather than axis xx.

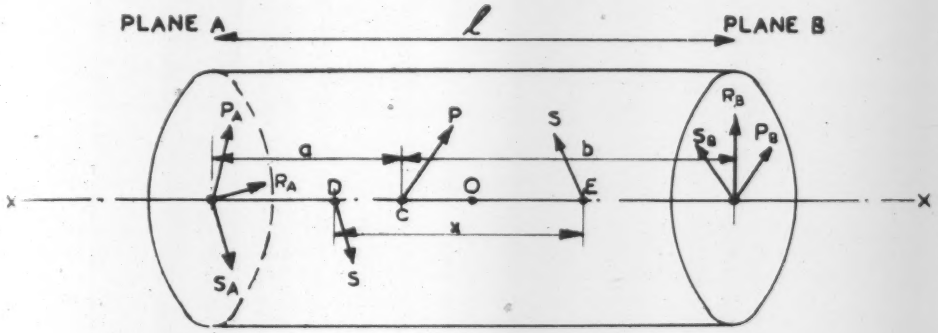


Fig. 3. Both P (moment due to static unbalance) and S-S (couple due to dynamic unbalance) can be resolved into forces P_A-P_B and S_A-S_B respectively, acting in the two end planes. This permits the balancing out of P and S by addition of forces R_A and R_B in the two given planes, where R_A is the vector sum of P_A and S_A, and R_B is the vector sum of S_B and P_B.

tude that the original out-of-balance couple is counterbalanced. In practice, this would amount to placing of the counterbalance weights along the appropriate plane while the body is in motion. In most cases this is not practical because the masses can occur in any plane along the shaft. Therefore, equilibrium is achieved by introducing the counterbalance weights in two convenient cross sections. It will be shown that balancing can be carried out in any two arbitrarily selected planes perpendicular to the axis of rotation. For convenience, and also to make the correction planes as far apart as possible (so that minimum correction weight is necessary) they are usually the end planes of the rotor.

Balancing the Static Unbalance Force

Let us consider a shaft (Fig. 3) rotating about an axis XX. Let P, the resultant of all forces due to lack of balance, act at point C as shown. The force P can be resolved into forces P_A and P_B acting in the planes A and B respectively, provided the following two conditions are fulfilled:

1. The sum of the resolved forces P_A and P_B is equal to the force P—that is, $P = P_A + P_B$
2. The sum of the moments of P_A and P_B about any point is equal to the moment of P about the same point. Thus, taking moments about point C, we get:

$$(P_A)\ (a) = (P_B)\ (b)$$

From the above two equations, we obtain:

$$P_A = P\ b/(a + b) = P\ (b/l)$$
$$P_B = Pa/(a + b) = P\ (a/l)$$

Thus we know both the magnitude and position of P_A and P_B. (Note: a + b = length l)

Balancing the Dynamic Unbalanced Couple

Let S be the resultant moment due to lack of dynamic balance. It is a couple, as shown. Any couple can be replaced by another one of the same moment, acting in the same direction. Thus, the couple S-S can be replaced by the couple S_A and S_B, such that $S_A l = Sx$

Thus the couple S-S can be replaced by the couple S_A and S_B in the two chosen end planes.

In this way we obtain two systems of forces acting on each end plane, and the two can be further simplified by the vectorial addition of forces in each plane, producing R_A acting in the end plane A, and a corresponding force R_B acting in end plane B, as shown in Fig. 3. If forces equal in magnitude and opposite in direction to R_A and R_B can be applied in their respective planes, balance can be achieved.

Electronic Balancing Techniques

It is evident that equilibrium of the forces and couples about the central axis can be achieved by static balancing. These same corrections must, however, balance out the other out-of-balance couple acting in a direction longitudinal to the rotating member. This second condition of balance would appear to be a difficult and lengthy operation. The development of suitable electronic circuits has now rendered this a routine operation which can be carried out by unskilled operators in short time.

An electronic balancing machine consists basically of three main parts: (1) *pick-up unit* which converts mechanical vibrations due to unbalance forces into electrical signals; (2) *control circuit*, where the correction planes

are resolved; (3) *amplifier and detector unit*, where the electrical signal is magnified and fed into indicators to denote the magnitude and angular position of unbalance.

One such device is shown in Fig. 4. It is a small portable unit designed for mass production balancing of small rotors, such as armatures of fractional-horsepower motors, small rotating servomechanisms, etc.

In this instrument, two coils are free to move within the field of two powerful permanent magnets; the coils are connected by connecting rods to two light-weight cradles and are free to move in one plane only. The workpiece is supported horizontally in "V" mountings carried on the cradles. A belt drive is used to rotate the workpiece. With the rotor thus mounted and the motor running, the unbalance in the workpiece will cause vibration of the supporting cradles, the amplitude of the vibration being proportional to the amount of unbalance. The movement of the cradles produces movement of the coils within the magnetic field. For a given angular speed, the emf induced in the coils is directly proportional to the amplitude of mechanical vibrations and hence to the amount of the unbalance. The electrical signal thus produced is then fed into a mixing circuit, the controls of which enable the operator to select the desired correction plane (by flipping a switch, the operator can read the out-of-balance mass at either end of the piece.). From the control circuit, the signal is fed into an amplifier unit and output indicator.

A filter network is included in the instrument to pass only those vibrations of the workpiece which occur once per revolution, eliminating spurious vibrations.

The *angular position* of the unbalance is obtained by a stroboscopic lamp. The lamp is caused to flash everytime the voltage in the pickup coils changes in polarity. From the flashing of this lamp, one of the numbered graduations placed on the workpiece can be read because the number will appear to stand still (the total resolved unbalance will appear at one position only and be indicated by one number). This numbered graduation indicates directly the angular location of the unbalance correction.

An indication of approximately 5% of the full-scale deflection results from a displacement of as small as 50 microinches peak to peak. The corresponding unbalance in inch ounces is given by the formula: *Weight of rotor in ounces*/40,000. The unbalance in inch-ounces does not tell directly how much weight to add or subtract; this weight is determined from a calibration made by the user, depending on the balancing method. The indicator is calibrated arbitrarily from 0 to 100, enabling users to calibrate it in terms of their own balancing methods.

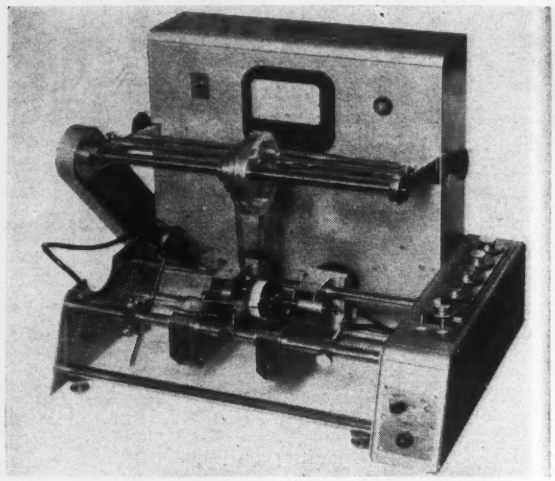


Fig. 4. Dawe Type 1250 is balancing machine using electronic techniques for establishing amount and location of unbalance.

The dynamic balance obtained in this manner makes corrections so that the sum of centrifugal or centripetal forces is zero. Such a dynamically balanced workpiece is in a state of static balance; the reverse is not necessarily true.

Variations of the instrument are available for handling rotor shafts mounted in a vertical position, etc. Further information on the equipment described is available from Dawe Instruments, Ltd. (Canadian Division), or The Hickok Electrical Instrument Co. Other electronic balancers are made by Steward-Warner, Gisholt, R. B. Annis Co., and others (see *I&A Handbook & Buyers' Guide*, under heading "Balancing Machines, Dynamic").

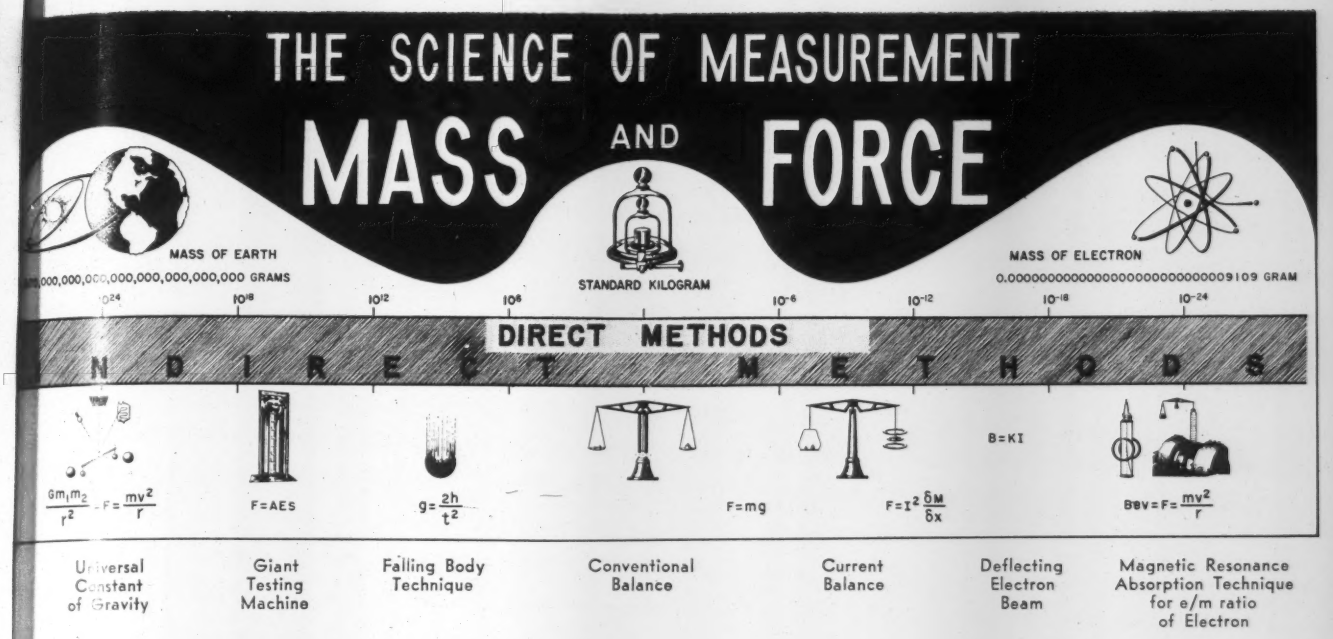
Science of Measurement

NBS Director A. V. Astin presented a lecture-demonstration on the science of measurement to guests visiting the Bureau during Guest Week, January 23-27, 1956. He spoke before a backdrop which showed how NBS mass and force measurements extend from the mass of the earth to the mass of the electron. Between these extremes are the 10-million-pound force exerted by the Bureau's giant testing machine and the relatively small force encountered in the current balance—yet all such measurements in this country are based on the *national standard of mass*, a kilogram cylinder. In making mass and force measurements it is important to know accurately the constant *g*, which defines an exact relationship between mass and force. The Bureau plans to redetermine *g* by the falling-body method (left of conventional balance).

The current balance (right of conventional balance) is used to derive the absolute ampere from the primary standards of length, mass, and time.

Deflection of an electron beam by an electromagnet (right of current balance) provides a means for relating the mass of the electron, through the current balance, to the standard kilogram. More accurate determinations of the electron charge-to-mass ratio have resulted from magnetic resonance absorption measurements (far right). Depicted at far left on the chart is the method for determining the universal constant of gravity G.

Dr. Astin limited his discussion largely to measurements of two quantities which are of great importance to science and engineering—mass and force. He discussed the Bureau's work in making measurements over the vast range extending from the mass of the electron (9.109×10^{-28} gram) to the mass of the earth (5.975×10^{27} grams). He pointed out that only over a limited portion of this



range is it possible to measure mass directly by means of balances. To measure either very large or very small masses, indirect techniques must be devised using electronics, optics, sound, atomic science, and other branches of physics and engineering. The guests were shown the national standards of mass and length—the meter bar and the kilogram—which, together with the rotating earth as a standard of time, constitute the three primary standards basic to all types of scientific measurements.

Dr. Astin brought out the importance of *g*, the acceleration of gravity, in establishing a relationship between mass and force. A simplified mockup of the method by which the Bureau plans to redetermine *g* was shown; the experiment will involve measuring the time required for a ball to fall freely in a vacuum. In 1936 the Bureau measured *g* with an accuracy of three parts in a million by means of the reversible pendulum. Because of the advances that have since occurred in electronic timing and optical measuring techniques, it is believed that greater accuracy can now be achieved by the falling-body method. In the final experiment on *g*, time and length measurements will be attempted to an accuracy of 3 parts in 10 million. If this is successful, the final result for *g* should have the desired accuracy—1 part in a million. The constant *g* is also important in the earth sciences—geology and geophysics—and in meteorological studies of the atmosphere.

Dr. Astin's discussion of the measurement of very large forces were illustrated by the calibration of a 1,000,000-lb dynamometer in the 10,000,000-lb testing machine, believed to be the most powerful of its kind in the world. Using the principle of the wire strain gage, the Bureau has developed compression dynamometers capable of measuring forces up to 3,000,000 lb, for use in calibrating multimillion-pound testing machines throughout the country. Previously the greatest load that could be accurately measured was approximately 2,500,000 lb, and this required the simultaneous use of several high-capacity proving rings. With the new dynamometers, calibrations can be performed more quickly and at considerably less cost.

Very small masses such as that of the electron are measured indirectly by making use of electric and magnetic forces. The guests were shown by actual demonstration how the Bureau derives the absolute electrical units from the basic standards of length, mass, and time. The demonstration experiment was then extended to give the mass of the electron in terms of these basic standards.

Derivation of the electrical units from the three primary standards was illustrated with the Bureau's current balance. This apparatus measures a current in absolute amperes by determining the mechanical force between two parts of the circuit in which it flows. The force between coils carrying the current is measured with a sensitive balance. From the value of this force and the mechanical dimensions of the coils, the absolute value of the ampere is computed in terms of the fundamental standards of length, mass, and time.

The *absolute ohm* is defined in terms of the primary standards by another experiment involving mechanical measurements; from these two derived units, the Bureau has set up standards for all other electrical quantities—such as voltage, power, and energy—in use today.

The guests were then shown how the current measured by the current balance can be used to deflect a stream of electrons. Since the amount of the deflection depends on the charge-to-mass ratio (e/m) of the electron and on the current in the deflecting coil, this experiment provides a means for relating the mass of the electron, through the current balance, to the standard kilogram.

To meet the needs of modern atomic and nuclear physics, the Bureau has developed a more accurate method for determining the gyromagnetic ratio of the proton, which incorporates a number of new developments in radio, electronics, and atomic physics. The method involves measurement of the magnetic field and radio frequency required for magnetic resonance absorption in a proton sample. This procedure makes possible the most accurate measurement of e/m ever obtained. Further increase in the accuracy of the method depends on the attainment of a more accurate value for *g*, which the Bureau hopes to provide.

Fig. 1. Hundreds of the 650 Magnetic Drum Data Processing Machines are now in operation.

Office Automation

Examples of actual applications show the dramatic savings and business-operation-analyses that are now possible with modern Magnetic Drum Data Processing Machines (MDDPC). Linear programming, statistical inference, and simulation are established techniques.

W. F. McCLELLAND
D. R. JAREMA and
R. M. JAMES
International Business Machines

EXPERIENCE of the past few years has shown that preparation for automation involves considerable study and research which themselves are costly. One promising facet of current research in automation is research directed toward the improvement of the economic performance of an enterprise. Major successes already have been achieved, as shown by the following examples.

Mathematical Programming

In order to attack a business problem with scientific technology, it is necessary to state the problem properly. For instance, a management might desire to minimize capital investment and to maximize profit. As these two objectives are likely to be incompatible, some preference relationship must be established before an optimum management program can be determined. A reasonable objective might rather be to maximize profit or minimize costs where available facilities such as capital, manpower, or machine tools are limited. For this type of problem, the new tools of mathematical programming are proving powerful, particularly *Linear Programming*. Linear programming is essentially a set of rules through which may be obtained the best (most profitable) solution to business problems involving limited capital or facilities. The solution is guaranteed to be optimum.

To be specific, consider an organization which has several producing plants and a number of wholesale distributors. Given the amount of production at each plant, the demand at the distributors and the unit transportation costs between plant and distributor, it is not a simple problem to find the exact quantity that should be shipped between each plant and distributor to minimize over-all transportation costs. If there are five plants and 80 distributors, there are 400 possible paths from the plants to the distributors. The rules of linear programming will select the 84 theoretically best paths and determine the amount shipped over each route that guarantees the total transportation costs to be minimum.

In one case, solution of this transportation problem by linear programming techniques has achieved a yearly savings in transportation costs of about $500,000.

Presented at: 2nd International Automation Exposition, Chicago, Nov., 1955.

Linear programming also can simultaneously adjust production and transportation paths so costs are minimum, total production equals total demand, and production at each plant does not exceed productive capacity.

Another successful application of linear programming is in the chemical industry in the blending of ingredients. The blending of crudes in oil refining is an outstanding example. The objective is to determine how the crudes and constituents like tetraethyl lead should be mixed to yield gasoline grades with most profit. The output products must have satisfactory quality characteristics such as octane rating and vapor pressure index. It appears that application of linear programming can result in a savings of two cents a barrel. When one considers that refinery output may easily be 50,000 barrels a day, savings of $1,000 a day may be realized. Other successful applications of linear programming have been made to nutritive diet blending, to machine loading, to labor allocation, to production smoothing, and others.

The rules of linear programming are carried out easily by a computer, which can provide solution economically and rapidly. The speed of solution can be of vital interest —if purchase of profitable raw ingredients can be consummated before competitors can make such determination, the payoff can be enormous; or speed may be necessary to be able to take action before market prices change. This point should be emphasized because a common misconception is that a computer must be well utilized to be profitable. It may be profitable to have a computer idle if it provides advantage of speed over a competitor who employs a fully utilized but less capable computer.

For most computers, instructions have been prepared to solve general linear-programming problems. IBM's most powerful computer, the Type 704, has available instructions which will solve linear-programming problems with as many as 255 restrictions and any number of unknowns. Solution time is roughly 87 milliseconds per iteration.

Statistical Inference

One organization in the metal-processing industry was studying yield; data were collected for several years. Sixty-three different facts had been recorded for 264 operating periods. Which of the 63 factors really affected yield? How did they affect yield? To isolate the significant factors and to determine the relationship of the significant factors to yield, management employed statistical mathematics and carried out the analysis by machine. The result was an experimental formula relating yield to the significant operating factors. The formula was tried in 30 consecutive periods and resulted in yearly savings of hundreds of thousands of dollars.

Simulation

Simulation is well known in engineering design. The intention is to simulate the performance of the full-scale product through the performance of the model. Of course, the model does not fully simulate the performance of the full-scale object, but if the experiment is designed sufficiently well, valuable results should be obtained much more economically than by constructing a full-scale or pilot model. Let us see how simulation applies to business and management problems.

Suppose a management is questioning its inventory policy. The organization has a reorder policy based on minimum safety level. If management raises the safety level, certainly increased inventory costs will result on the higher protective level. On the other hand, if the safety level is reduced, then more frequent out-of-stock situations will occur. In order to determine the relationship between minimum safety level, supply breakdown, and inventory costs, a computer can be used to simulate the entire operation of the inventory system.

There are essentially three parts to simulation: simulation of requisitions against stock, the filling of the requisition, and finally the reorder of stock in order to replenish depleted items. In order simulate historical requisitioning, historical demand information is collected and a probability function of the demand prepared from this information. Then, with a set of random numbers, a computer can produce stock demand which have the same statistical characteristics as the historical demand. These requisition figures are used by the computer to apply against inventory and reorder is made under, say an assumed minimum safety level rule. The computer then repeats the process applying against new demand filling the requisition and testing for reorder. Such a procedure can be done at extremely rapid rates; in a few minutes, literally years of experience can be gained.

The next step is to change the minimum safety level rule and repeat the procedure. A large number of reorder rules can be tried and the various effects recorded. In this way the interrelationship between these quantities is determined. At this point management can decide how it wants to set the safety level knowing what breakdown to expect, and what inventory costs to expect. Indeed, management can make a decision as to minimum safety level without incurring the experimental risks of dissatisfied customers or additional inventory costs which might be incurred should an experiment be made with the business operation itself.

The competitive nature of business will even further magnify the application of the scientific approach to business problems, which will, in turn, demand more powerful computers. Manufacturers can supply the computers; the major difficulties will be in problem formulation and development of mathematical solution technology. This challenge to creative thinking will have a profound effect on the productivity and economic performance of the individual enterprise.

650 APPLICATION AT THE A. C. NIELSON CO.

D. R. JAREMA

THE A. C. NIELSEN COMPANY, widely known as the "World's Largest Market Research Organization," has been engaged continuously since 1933 in what might be called "mass marketing" and mass radio-television audience research. Their marketing research is focused primarily on drug and food products; original field data come from repetitive 60-day audits of invoices and inventories on about 150 commodity lines, in a combined group of more than 3000 sample retail drug and grocery stores. The Nielsen Company has offices in ten countries. In the United States they employ about 200 field men to gather primary data at the retail level, and have approximately 1100 employees at their data-processing headquarters in Chicago.

Field data collected for food and drug index services consist principally of manual entries on special columnar forms. These forms show a column of figures covering the prior sixty days' activity on the designated item in the single, specific sample store. These entries show:

(1) Prior and current inventories.
(2) Retailer purchases, order by order.
(3) Computed consumer sales, in units, based on purchases plus or minus the inventory change.
(4) Consumer selling prices on data of the audit, from

Fig. 2. The Type 704 is IBM's most powerful computer.

which the dollar value of the unit sales can be computed.

(5) Observational entries reflecting point-of-sale promotion in the form of displays, feature pricing, couponing, and premium distribution.

Each bi-monthly cycle of food and drug index operation brings by mail to their Chicago office nearly 350,000 sheets of the field data described; these sheets carry about 1,500,000 columns of current figures. Their Chicago "figure factory" receives and processes about 150,000,000 decimal digits of original field data in each bi-monthly period.

Each and every digit of this field-reported information finds its way into IBM *punched cards*. This is nominally at the rate of one so-called detail card per column of original field data. A minimum of 1½ million IBM punched cards are used every two months, in a department staffed with 22 key-punch operators.

Tabulating is the next process in their report production cycle. The purpose here is to sum up like data from all stores and then mathematically to "project" the sample store data into equivalent totals representing the aggregate bi-monthly movements of each commodity through the entire universe of retail drug or retail grocery outlets. The first step is sorting the 1½ million detail cards into product-class-by-item sequence. Sub-sorting then divides the cards for each product class into about 125 so-called projection cell groups (determined by type, size, and geographic location of the stores from which the original data came). This sets the stage for their arithmetic projection of sample store data on purchases, sales, and inventories by means of a series of 125 expansion factors, as determined by the stratifications employed in their area-probability sample design. A second variable in the projection-control equation is the so-called elapsed-day factor, which automatically compensates for variations in the field-audit interval.

Tabulated data move finally into the *Computation*, *Inspection*, and *Reproduction* sections. Here a total of about 100 equivalent full-time people are employed on what might be regarded as the hand-finishing operations. These people are responsible for preparing the final reports, charts, and tables which go to make up the client's report, which is presented to him each sixty days.

The Nielsen Company has at present two IBM Type 650 MDDPM's, both on a two-shift operation. Several additional units are on order.

Marketing Research Problems

One major problem concerns a distribution to obtain maximum and out-of-stock percentages. Maximum refers to all stores handling a given product, such as a particular brand of soap. Out-of-stock percentages refer to the percent of stores normally handling an item but out of stock at time of audit.

It formerly took 1370 hours of machine processing on conventional IBM equipment and approximately six full-time people with desk calculators in another department to perform this editing operation. By use of the IBM 650 and IBM 407, they were able to eliminate the desk calculator operation, and to reduce the machine processing time on punched card equipment from 1370 to 720 hours. This operation takes about 300 hours of the Type 650 production time per month.

Another phase of their operation which utilizes the Type 650 involves the reading in of one card for each item, which contains sales, purchase, and inventory units, as well as sales and purchase value. The 650 then determines whether the sales, purchase and inventory units should be converted to a different unit of measure. For example, ounce-packages of tea may be converted to pounds or cups of tea.

This operation formerly took nine 604 runs, five 416 runs, 4 sorts, 1 reproducer operation, and several clerical operations. It is now processed in one 650 operation and is accomplished in about 1/12 the time.

Another operation involves developing of tables according to the format specified by the client. Previously the information was summarized on a 416 to obtain intermediate format cards which were, in turn, processed through a 604 to develop percentage figures. The cards were then arranged and listed on a printer and were subsequently inspected and used by the statistical typist to prepare the final tables for insertion in the client's report.

By using a standard program with variation programs for each client's format, Nielson is able to process the data in one operation and, as output, get a Cardatype card which is used, together with master cards, to automatically type the client's report.

To sum up the 650 program at Nielsen: (1) The 650 was utilized immediately by the customer in their operation. (2) Each problem combined several operations previously done by conventional equipment in addition to eliminating manual labor. (3) The 650 has helped to

process the data more quickly. (4) As the machine has a punched-card input and output, it could in effect be used in any phase of their operation without major procedural changes because its input and output was compatible with their previous method.

650 APPLICATION AT MONTGOMERY WARD

R. M. JAMES

MONTGOMERY WARD AND COMPANY is one of the most advanced firms in the field of electronics today. With their consent we are happy to be able to discuss with you the applications which Montgomery Ward has installed on its Type 650, the reasons why they chose this machine, how they have arrived at the point where they are today, and what additional advantages have developed.

Problem Preparation

One of the most difficult things for people to recognize adequately in this field is the time and effort required to make a successful installation of electronic data-processing equipment. Mr. Marion Hughes, Director of Methods at Montgomery Ward, informs us that approximately two man years were consumed in the process of getting to the point where Montgomery Ward could accept delivery of the Type 650. Some of this time was devoted to attendance in the basic and advanced classes on 650 programming offered by IBM. Also, the programs that had been written were scrapped many times as additional insight and experience was gained, resulting in improved plans for utilizing the Type 650. The preparation of budgets had been programmed and tested in Endicott by the time that the machine was delivered. The Profit-and-Loss statements had been programmed but not tested. Since the machine was delivered last spring, probably an additional five more man-years have been spent in furthering this installation.

Personnel charged with block diagramming and programming must be given adequate time to think deeply and work without daily harrassment and interruption. Block diagramming and programming requires a great deal of concentration over a long period of time. Interruption breaks this pattern and results in lost time.

There is no substitute for adequate personnel properly prepared by thorough knowledge of applications, retail store budgets and Profit-and-Loss statements, knowledge of punched-card procedures, and experience with the Type 650.

While the basic staff was recruited from within the company, Ward's has also expanded its personnel by securing competent people from outside the company. This has permitted continued research into new fields while the first installation has been progressing.

It appears to be desirable to assign people in pairs to the various applications involved in making an installation. This enables a high degree of mutual stimulation and the development of soundly tested procedures. Once the basic plan has been formulated, the details can be worked out by individual effort. However, there seems to be no substitute for joint effort in working out the over-all plan.

Advantages Realized

One of the real advantages to date has been the processing of a great mass of information dealing with the cost of handling various types of orders in the mail-order houses. This was a non-repetitive cost analysis. It was possible to program and process this information in about the same time that would have been required to process it manually, and at considerably less cost. The accuracy attained is higher and the programs are prepared and tested, making future analyses less expensive and less time consuming. Furthermore, a start has been made in describing the over-all application of a mail order house mathematically. This may result in a development of some highly advanced techniques of "Operations Research" as the result of completing the construction of a mathematical model of the operation of a mail-order house.

Another significant advantage which was not fully foreseen was the degree of accuracy. It has become apparent that the ability of the Type 650 to maintain many elaborate controls through careful programming has provided a degree of accuracy that probably could not have existed even under the previous punched-card system and certainly could not have existed under any manual system.

The applications described have actually taken place. This is not what *might be* a success story of 1956—this is a success story of 1955.

Budget and Profit-and-Loss Statements

Two major reports which Montgomery Ward prepares by means of its Type 650 are *operating budgets* for the retail stores and *profit-and-loss* statements for the retail stores, prepared each month for each store. As there are approximately 600 stores in the Montgomery Ward retail organization as well as about 35 additional store groupings into districts and regions for managerial control, the volume in these applications is considerable. Prior to utilizing the Type 650, these applications had been mechanized on punched cards using Type 604 electronic calculators.

To prepare the budget for a retail store, a work sheet showing the actual amounts in each income and expense category for the corresponding month of the previous year first is prepared by means of the IBM cards which were used to prepare the profit-and-loss statements last year. This work sheet is sent to the store manager, who places on the work sheet the amounts which he considers appropriate for this year's budget.

Then the information concerning last year and this year is introduced into the 650. All of the appropriate sub-totals are calculated by the 650, percentages of each item to one of five bases are computed, all of the necessary information to prepare the final budget, line by line, is assembled and checked, provision for store manager's extra compensation is computed through a series of simultaneous equations, and district and regional totals are accumulated in one operation by the Type 650. The output is IBM cards which contain the actual amount of the corresponding month of last year percented to its appropriate base, and the budgeted amount for the coming month of this year percented to its appropriate base for each of approximately 100 lines on each budget. Also, as a result of completing the processing on all of the stores within a district it is possible to punch out similar cards with accumulated district totals for each line on the district budget. These cards then can be listed on an accounting machine to prepare final budgets for all of the stores and districts in the retail structure.

At the close of the month all of the information concerning the amounts actually earned or spent during the month are punched into IBM cards.

Once the actual amounts for the month have been assembled and prorated they can be introduced into the 650 along with the IBM cards created during the budget

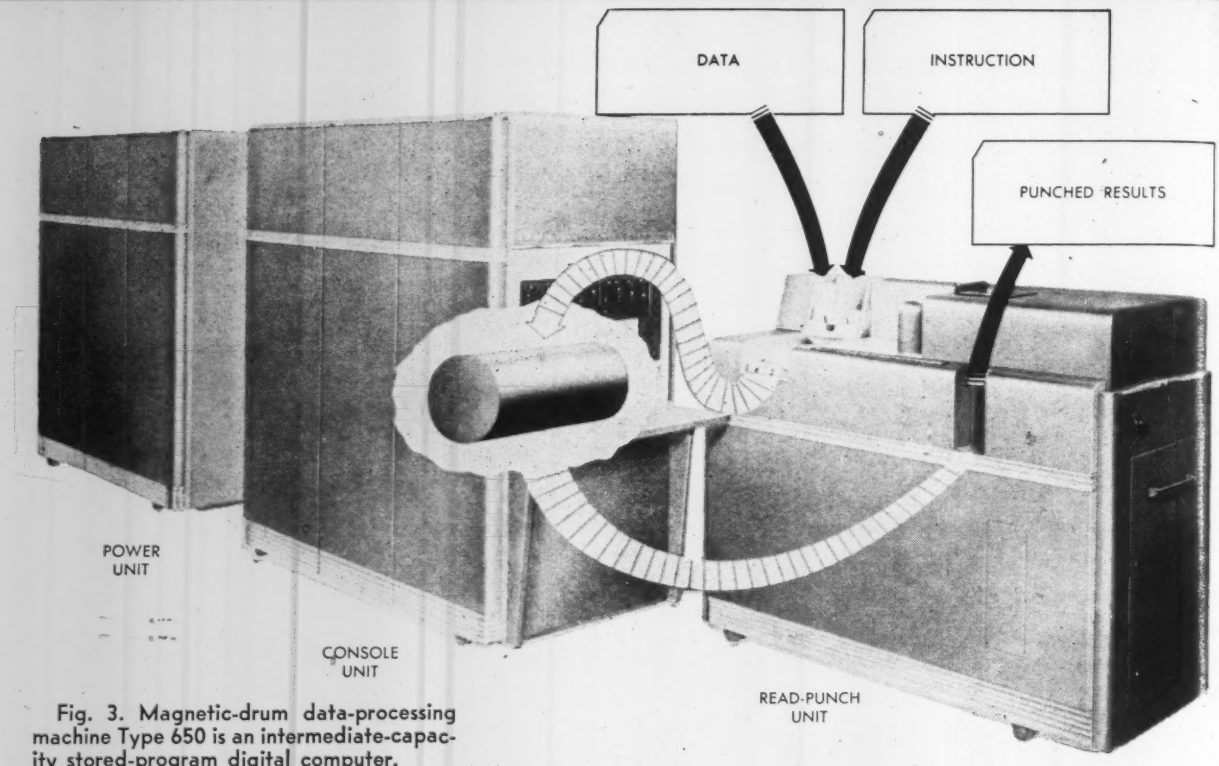


Fig. 3. Magnetic-drum data-processing machine Type 650 is an intermediate-capacity stored-program digital computer.

operations described. This information is used to develop all of the various sub-totals in the profit-and-loss statement, compute the percent of each amount to its appropriate base, compute new year to date amounts for each line, and accumulate district totals for each line. The output consists of IBM cards on which information is assembled concerning the actual amount for the corresponding month for the previous year and the year to date of the previous year, the budgeted amount for this year, the actual amount for this year and the year to date for this year, all percented to their appropriate bases. These cards can then be placed into an accounting machine and used to prepare profit-and-loss statements. Current-month figures for this year are compared with those of last year. Also, year-to-date figures for this year are compared with those of last year. Finally, the actual figure for the current month is compared with amount previously budgeted. All of this is presented for each of about 100 lines on the profit-and-loss statements.

The type of processing necessary is really more complicated than this description might seem to indicate for several reasons: First the base to which each item is percented is not identical in all cases. For example, sales this year are percented to sales last year, while maintained rate of gross profit this year is percented to sales of this year, and selling wages for hard goods are percented to the sales of hard goods. Secondly, the extra compensation paid to a store manager is based upon the net profit after taxes, but the net profit after taxes is the result of subtracting the provision for income tax from the net profit prior to taxes, and the profit prior to taxes must be arrived at as the result of including the extra compensation paid to the store manager as an expense item. Here we have three separate figures, all dependent upon each other. The solution lies in setting up and solving three simultaneous equations. Finally, the various items are either added or subtracted into a whole series of different sub-totals as well as the final total, the net profit after taxes. These resulted in the necessity for handling certain items on an exception basis as long as the profit-and-loss statements were being prepared by means of a 604 electronic calculator. In fact, the volume in each of the exceptions and the number of exceptions were so large as to raise a question of whether there was a truly main procedure. The type 650 has demonstrated its ability to process all of these items from raw input to finished output with no deviation from the sequence followed in the profit-and-loss statement.

In addition to these two basic reports, a complicated inventory control report has now been programmed, and this report is being processed by the 650, starting September, 1956. The 650 has also been used frequently for small, non-repetitive problems and has saved much time and effort. An example is the preparation of depreciation "lapsing" schedules. These schedules were prepared in a minute fraction of the time usually required by laborious hand posting and calculating methods.

Why These Applications?

There were probably two principle reasons underlying the selection of these applications. First, a careful survey indicated the possibility of reducing by many thousands of dollars each year the cost of preparing these reports. These savings will result from reduced machine rental to IBM as the result of replacing a number of 604 Electronic Calculators, Reproducers and Accounting Machines, reduced personnel required to run one Type 650 in place of 12 or 13 machines being replaced, and reduced manual clerical costs for some of the calculations which had been processed previously on desk calculators.

Second, Montgomery Ward also saw an opportunity to gain valuable experience in harnessing electronics and data processing to clerical tasks. The use of the Type 650 on these applications offered Montgomery Ward an opportunity to learn a great deal about data processing prior to jumping into other applications. Larger machines, if and when they become desirable, can be evaluated more easily by Montgomery Ward as a result of experience gained in programming and installing this first machine.

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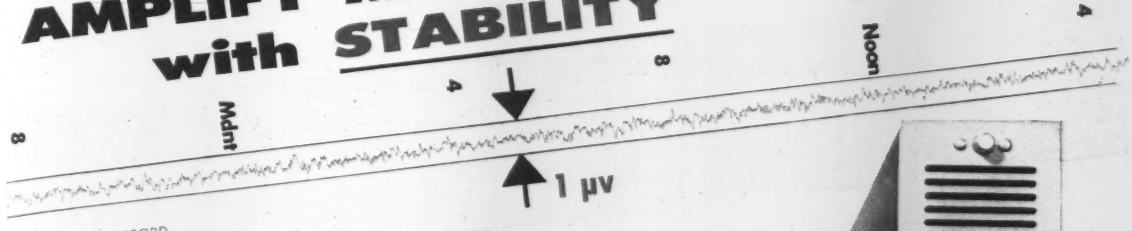

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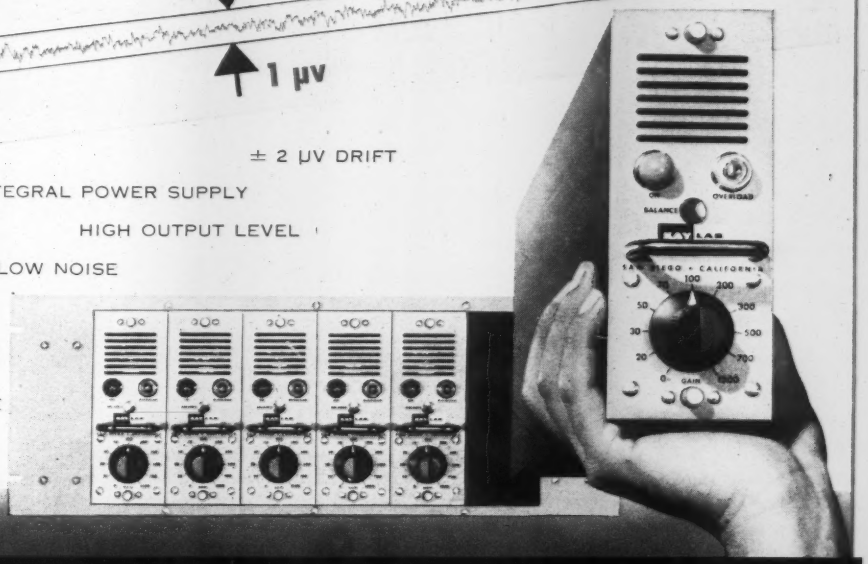

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Input Impedance	100,000 Ω
Output Capability at DC	0 to ± 35 V where R_L > 1000 Ω 0 to ± 40 MA where R_L is 10 to 400 Ω
Output Impedance	Less than 1 Ω in series with 25 μh
Equivalent Input Drift	± 2 μv with regulated line
Equivalent Input Noise	0 to 3 cps, less than 5 μv peak to peak 0 to 750 cps, less than 5 μv RMS 0 to 50 kc, less than 12 μv RMS
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Instrumentation for AIR POLLUTION

Here is a thorough review of the air monitoring program of the Los Angeles Air Pollution Control District, including the monitoring and recording instruments for sulfur dioxide, oxidants, carbon monoxide, nitric oxide, nitrogen dioxide, particulate sampling, and ozone. Principles, calibration, and operation of the instruments are discussed in detail.

ROBERT J. BYRAN*
J. C. ROMANOVSKY**
County of Los Angeles

MEASUREMENT of air contaminants, quantitatively, is a requirement for successful air-pollution control. In order that continuous information be available without lengthy delay due to manual analytical procedures, sampling and analysis by means of automatic recording instruments is highly desirable.

Early efforts in the development of automatic instruments for air monitoring were for the most part stimulated by the necessity to measure specific known contaminants. One of the first of these instruments was the sulfur-dioxide Autometer developed in the 1920's.[1]

Major incidents in the Meuse Valley (Belgium), Donora (Pennsylvania), and Poza Rica (Mexico) have further demonstrated the desirability of air sampling data. In these tragedies, little or no atmospheric sampling data were available. Consequently, large sums of time and money were spent to painfully reconstruct what might have happened during these incidents. As valuable as post-mortem examinations may be, they are poor substitutes for direct evidence. They are of no use in warning of pollution build-up toward undesirable and possibly toxic concentrations.

*Principal Engineer, Air Pollution Control District, County of Los Angeles.
**Chemist III.

Portions of this article prepared by Mr. Romanovsky were delivered before the May 1956 meeting of the Air Pollution Control Association.

It has been part of the Air Pollution Control District policy since its formation in 1947 to develop and place in operation a comprehensive air sampling network, based as much as possible on automatic sampling and recording instruments.

The Los Angeles Program

Air monitoring, meaning continuous analysis of atmospheric contaminants, is presently being conducted in the Los Angeles Basin with an approximate coverage of over 1,000 square miles. This is accomplished through the operation of automatic instruments and other sampling equipment at 15 permanent stations and at certain other temporary or mobile stations (Fig. 1).

The 15 permanent stations are strategically located so as to cover the basic surface wind trajectories established by various micrometeorological studies [2, 3]. Other stations are located for pin point studies of specific sources or small areas.

The total air sampling program of the Air Pollution

January Meeting *will be Annual Instrument Short Course, Los Angeles Harbor Junior College, Wilmington, Calif., January* 31st *to February* 2nd.
Featured Speaker: *Jack K. Walker, Project Chief-Systems from Consolidated Electrodynamics Corp.*
Subject: "Process Control—Today and Tomorrow."

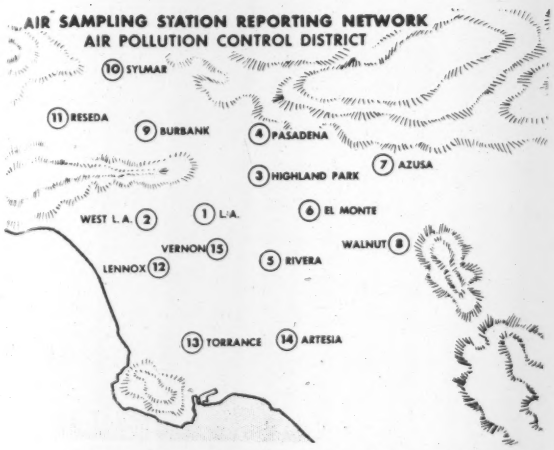

Fig. 1. Map showing air monitoring stations, Air Pollution Control District, County of Los Angeles.

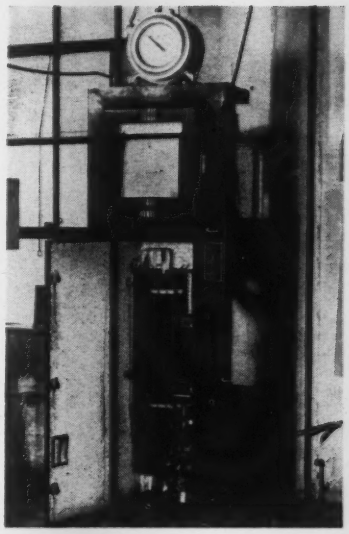

Fig. 2. Thomas Autometer for measuring SO_2.

Control District involves the regular atmospheric analysis for the components listed:

Aldehydes
Carbon Monoxide
Nitrogen Dioxide
Sulfur Dioxide
Ozone
Total Oxidants
Nitric Oxide
Hydrocarbons
Ether Soluble Aerosols
Particulate Matter
Background Radioactivity

Automatic sampling and recording instruments are in use for CO, SO_2, NO_2, NO, total oxidants, and background radioactivity. Other automatic instruments are now in the developmental stage. Certain other instruments for the measurement of meteorological variables and physical phenomena are located at previously mentioned and other stations throughout the basin. These variables include *wind velocity and direction, inversion conditions, temperature, humidity* and *solar radiation.*

The objectives of the air monitoring program are: (1) To guard the public health against any concentration of pollution such as has produced crisis elsewhere. This is required by law under Regulation VII, Air Pollution Control District's Rules and Regulations. Only those pollutants present in the atmosphere which are known to be toxic in low concentrations are involved. A series of emergency actions are provided for as concentrations build up beyond well-defined levels. (2) To provide a basis for a zoning program to locate new industrial activities in areas where they will not add to contamination already present. (3) To obtain further information on the nature of reactions which occur in the atmosphere. Control measures are based to a large extent upon these findings. (4) To make comparison between various portions of the Los Angeles Basin and to measure the progress being made in the control of air contamination.

Measurement Principles

In air pollution monitoring, unlike analytical measurements for process control, the ultimate goal is to obtain a record of the true instantaneous concentrations as a function of time. Therefore, every effort is made to measure a variable which is specific for the particular component being measured and which has a high correlation with the true concentration over the entire operating range.

In practice most of the instruments used in air monitoring are *recording colorimeters* or *spectrometers.* Others are used which measure *conductivity,* determine *titration end points,* measure *light transmittance* or *reflectance,* and which measure *light scattering.* Instruments for the measurement of the various forms of radioactivity form a large separate class.

Energy detecting devices used in these instruments include thermocouples, thermopiles, and thermistors to sense heat which may be absorbed or emitted in chemical reactions or as a result of a physical property. Capacitor microphones measure pressure variations. Electrolytic cells provide for the measurement of electrical conductivity. Barrier-layer cells and phototubes respond to the absorption or emission of visible or ultraviolet radiation. These sensing devices are augmented by electronic amplifiers and recorders to provide continuous recording of the measured variable.

A number of reviews of all types of air sampling instrumentation have been made by others. Some of these are very comprehensive and quite recent[4].

Basic Instrument Types

Most of the problems in air monitoring instrumentation arise because of the very low concentrations of components existing in the atmosphere and because of the heterogeneous and random nature of interfering substances. This is generally not the case in process control instrumentation. For the most part gaseous pollutants exist in the 0-100 *parts per hundred million range.*

Two broad categories of instruments are in use. They may be classified as *physical instruments* or *chemical instruments.* The first broad class would include spectrometric instruments, light scattering devices, radioactivity detecting devices, etc., where a specific property of the variable itself is measured. The second broad class includes those instruments in which the component of interest undergoes a reaction with some reagent contained in the instrument and some subsequent change in property such as color development, conductivity, or potential difference is detected and recorded.

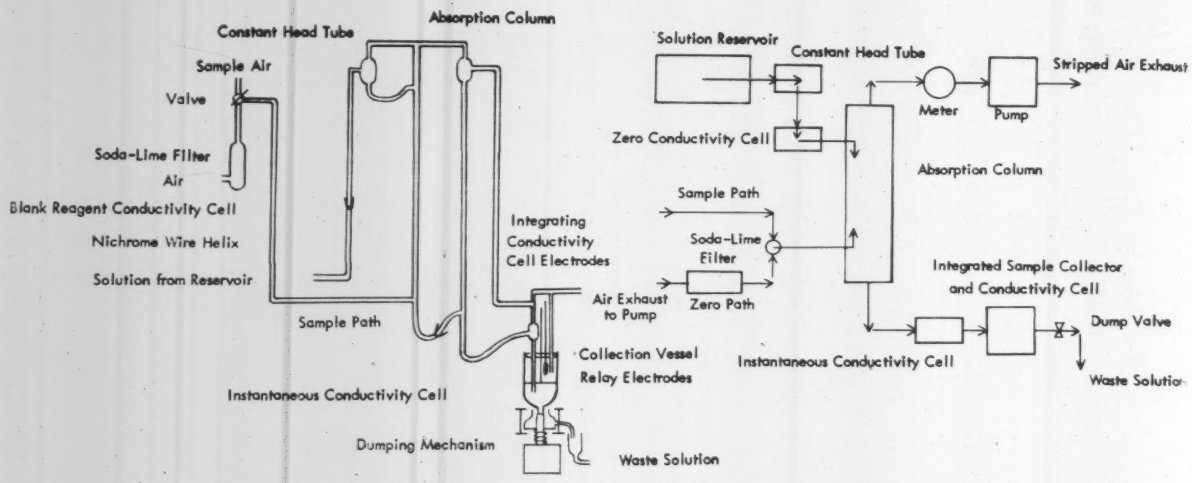

Fig. 3. Schematic flow diagram of Thomas Autometer. Left, elements; right, block diagram.

Both general classes have advantages and disadvantages. Physical instruments can usually be expected to be more specific, have shorter response times and have fewer maintenance problems. They generally produce a lower signal level and consequently are more complicated electronically and have a lower signal-to-noise ratio.

Chemical instruments, by means of the reaction taking place, produce a measurement variable which is more easily detected and consequently are usually more sensitive. However, they have greater operational problems and a lower degree of specificity. Most require a liquid-gas absorption system and have various reaction chambers. Because of liquid hold-up and reaction kinetics, instrument response is slower and values recorded are generally integrated values. There are other problems resulting from reagent use, including flow control at low liquid rates, reagent stability and corrosion of equipment parts.

Calibration

All analytical instruments must be properly calibrated. Dynamic calibration over the entire range of the instrument is vital. Calibration materials should be introduced in the same form as found in the atmosphere, although this is not always easy.

Automatic recording instruments for air monitoring are relatively new. Demand, numerically speaking, is not high. Consequently, most instruments are built on order only and are expensive. Some of the instruments used by the Air Pollution Control District are as follows:

Sulfur Dioxide Recorder

Sulfur dioxide is measured by the familiar Thomas Autometer (Figs. 2 and 3) which, to date, has been supplied by the Leeds and Northrup Company. The principle consists of the counter-current absorption of the sulfur dioxide in a wetted wall column, with simultaneous oxidation to sulfuric acid and measurement of the enhanced electrolytic conductivity of the solution.

Instrument calibration is performed under both static and dynamic conditions. The static method consists in operating the instrument on air which has been filtered through carbon and soda-lime, and blank reagent to which has been added a known concentration of sulfuric acid. The dynamic method involves the use of a synthetic mixture of filtered air and sulfur dioxide with simultaneous sampling of the stream for a reference analysis. The reference method is one of titration using a double indicator of brom cresol green and methyl red.

The interference effects from sulfuric acid aerosols and nitrogen dioxide have been found to be extremely low at the concentrations at which these components are found in the atmosphere. Hydrogen sulfide and hydrogen chloride would interfere, but these compounds do not contribute materially to the Los Angeles smog problem. The over-all accuracy of the method is of the order of plus or minus 10 percent although it may well be less accurate at concentrations below one part per million. The range of the instrument is zero to five parts per million on a linear scale. Range change is accomplished by changing resistors in the bridge circuit.

There are three items of operational difficulty with the instrument. The first is a tendency for the formation of bubbles in the flow system, resulting in erratic response by the conductivity cells and interference with the liquid flow. The detrimental action of bubbles is aggravated in the newer instruments where the reagent flows by syphon action and their presence destroys the necessary vacuum. Instruments of this type are improved by conversion to gravity feed. Some reduction of the bubble problem may be accomplished by frequent cleaning of the flow system with alcoholic potassium hydroxide.

The second source of trouble is in the temperature control of the system. Adding individual constant-temperature enclosures for each conductivity cell might provide more positive control because the volume affected would be smaller.

The third chief difficulty lies in the erratic operation of the dumping mechanism of the integrated cell. Serious consideration is being given to the elimination of this entire unit and installation of a rotameter to indicate the liquid flow rate.

Oxidant Recorder

Next to be described is the Beckman Oxidant Recorder, developed by Dr. Littman at Stanford Research Institute[5] (Fig. 4). The principle of this instrument is based on the reaction of the oxidants in an air stream with a buffered 20% potassium iodide reagent in a counter-current

contact column packed with glass helices. Measurement of the iodine release is made automatically by a recording double-beam colorimeter.

Liquid flow is by gravity from a constant head reservoir and the flow rate is adjusted manually through a rotameter at 5.0 milliliters per minute. The air flow is maintained at 5.0 liters per minute through a rotameter and controlled by a by-pass at the vacuum pump. The reagent is recycled (by means of a Sigma pump) and freed of any iodine by filtration through a granular carbon filter, immediately before entering the contact column. The colorimeter assembly is housed in a black box and consists of a single mercury vapor lamp, a Corning optical filter (which transmits a narrow band of radiation in the 360-millimicron region) and two barrier-layer cells. A 20.0-mm Pyrex sample cell, through which the iodine-enriched reagent flows, is located in front of one of the barrier-layer cells while an adjustable beam-attenuator is interposed in the reference path to the other.

The two barrier-layer cells are connected, in a ratio measuring circuit, to a 10-mv Brown recorder. Instrument zero is established automatically once a day by completely by-passing the sample air. Any occasional drift from zero can be corrected for by adjusting the position of the beam attenuator in the reference path. The effective range of the instrument is 0-80 parts per 100 million on a logarithmic scale, and may readily be converted to 150 parts per 100 million by increasing the liquid flow rate while reducing the air rate.

The instrument is calibrated both by static and dynamic methods. The *static method* involves passing a standard solution of iodine in the filtered potassium iodide reagent through the sample cell and noting the recorder response (the method originally used by Littman[5]); a somewhat similar calibration may be accomplished through the use of standardized physical filters. The *dynamic method* involves use of known concentrations of ozone as determined by chemical means. The ozone is prepared from medical grade oxygen by irradiation with an ultraviolet lamp, and nitrogen is added to the calibrating stream to approximate the composition of air. The stream is split, with one portion going to the instrument and the second to a train of micro-impingers containing a 2% aqueous potassium iodide absorbing solution. The chemical reference test is continued at an air flow rate of one liter per minute for a 45-minute period, when the contents of the two impingers are combined, acidified with sulfuric acid, and immediately titrated with 2×10^{-3}N sodium thiosulfate using starch as an indicator.

Interference effects due to nitrogen dioxide and sulfur dioxide have been investigated. Nitrogen dioxide in the absence of their oxidants possesses approximately 25 percent of the iodine release potential of ozone. Tests conducted with mixtures of nitrogen dioxide and ozone have been inconclusive. Preliminary findings indicate that the effect may be either positive or negative, depending on the individual concentrations and ratios of the residual components. Sulfur dioxide has a negative effect because it reacts with any iodine which is released and has a counter ozone equivalence of approximately 25 percent. The effects of other reducing agents such as aldehydes are presently being investigated.

Provided that individual calibration factors have been accounted for, the accuracy of the method is a function of the concentration and system lag. As the scale is logarithmic, the recorder responds at a rapidly descending rate as the concentration of oxidant rises, particularly at concentrations above 50 parts per 100 million. At high concentrations a yellow deposit forms in the contact column which is not readily washed away, thus aggravating a lag condition which is already too high. Wetted-wall columns with reported high efficiencies and low lag are now being offered commercially, but have not yet been evaluated by District personnel.

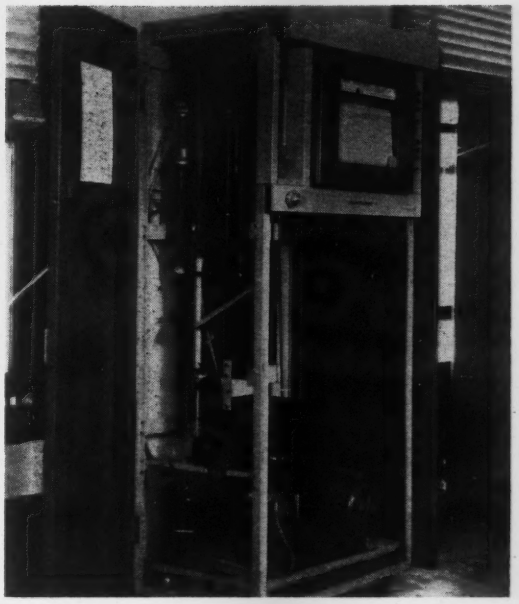

Fig. 4. Beckman total oxidant recorder.

Carbon Monoxide Recorder

Carbon monoxide is analyzed by means of the M.S.A. Gas Analyzer incorporating the Luft principle of non-dispersion infrared spectroscopy (Fig. 5). Radiation from separate nichrome sources is alternately transmitted through two parallel cells (29½ inches in length) at a frequency determined by a chopper. One of the cells contains pure nitrogen as a reference gas and the other contains the flowing sample. The alternating beams are focused on a single detection cell which contains carbon monoxide in argon and encloses a capacitor microphone.

The carbon monoxide gas in the detector heats up as a result of absorbed infrared radiation and expands against the capacitor plate. When less of the radiation specific to carbon monoxide reaches the detector cell through one alternating beam than the other, the gas in the cell would normally expand and contract in unison with the chopper frequency. In practice the instrument operates on the null balance principle, which means that the capacitor microphone remains essentially motionless. This is accomplished by a feedback mechanism connecting the recorder pen to a Helipot which controls the output of the reference source.

Other atmospheric components, like carbon dioxide and methane, though not possessing the same spectrum as carbon monoxide, absorb radiation at wavelengths in common with it. The effect due to these components must be minimized. This is accomplished by placing an additional cell in the optical path which is common to both the reference and sample cells, and which contains a relatively high concentration of the interfering components. In this way any source of radiation which is com-

mon to the gas analyzed and the filtering gases will be almost completely absorbed and have a negligible effect on the detector.

The range of the instrument is variable, depending on the pressure to which the sample gas is raised and the voltage supplied to the control Helipot. The instrument was designed for a full-scale deflection by 25 ppm of carbon monoxide, on a linear scale, at a sample pressure of 40 psig. By operating at atmospheric pressure and reducing the setting of the span control, the instrument range has been converted to 0-100 ppm. A manual zero adjustment is provided through a dial control of the voltage to the sample glower. Calibration is performed manually by switching the sampling manifold to a cylinder containing a known concentration of carbon monoxide and adjusting the span control dial to vary a bucking voltage which regulates the radiation from the comparison source. The over-all characteristics make this a practical instrument for field use except for the relatively short noise-free life of the electron tube in the preamplifier section.

Nitric-Oxide—Nitrogen-Dioxide Recorder

A combined nitric-oxide and nitrogen-dioxide analyzer has been manufactured by Borman Engineering, Inc. (Fig. 6). Instrumentation principles are similar to those used in the total oxidant recorder. The chemistry involves conversion of nitrogen dioxide into nitrous and nitric acids with subsequent diazotization of sulfanilic acid (in acetic acid solution) and coupling with N-(1-naphthyl)-ethylenediamine dihydrochloride[6]. Nitric oxide is measured in a separate flow system after oxidizing it to nitrogen dioxide with ozone produced by a regulated ozonator provided for this purpose in the instrument itself. The reactions take approximately ten minutes for completion, and provision for this interval is made in the design of the tubes leading from the contact columns to the optical cells.

Reagent flow is by positive displacement from a five-gallon bottle through two seperate syringe pumps at rates of 2.16 ml per minute. In the nitric oxide circuit the reagent proceeds directly into the counter-current contact column, thence through the proper measuring cell and into the spent reagent bottle. Prior to entering the contact column of the nitrogen dioxide system, the reagent flows through the comparison cell. Air flow rates are metered through rotameters at 225 and 235 ml per minute, respectively, through the nitrogen dioxide and nitric oxide channels.

The colorimeter assembly consists of a single tungsten lamp focused on three optical cells: the blank reagent cell, the nitrogen-dioxide sample cell and the combined nitrogen-dioxide—oxidized-nitric-oxide sample cell. Located between these cells and their respective barrier-layer cells are Corning filters which transmit radiation in the 550-millimicron range. The barrier-layer cells are connected to a Brown recorder in two separate circuits so that alternate readings of the nitrogen dioxide and the combined nitrogen-dioxide—oxidized-nitric-oxide are obtained.

Static calibration of the instrument is performed by introducing a standard solution of sodium nitrite in absorbing solution into the measuring cells while the reference cell contains the same reagent free of any nitrite. This procedure is being modified by the District so that the calibrating solution as well as the blank reagent can flow by gravity at regular rates through their respective cells. The factor for relating sodium nitrite to nitrogen oxide has not been established without question inasmuch as some of the nitrogen dioxide appears to react directly with the sulfanilic acid without first being converted to nitrous and nitric acids.

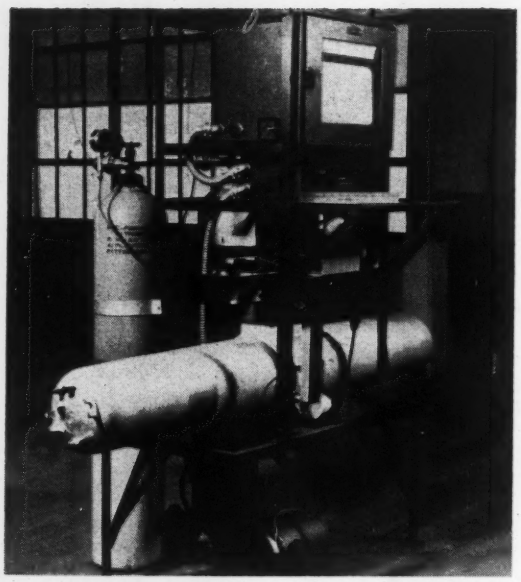

Fig. 5. M.S.A. gas analyzer for carbon monoxide uses Luft principle.

Dr. Saltzman states that one mole of nitrogen dioxide produces the same color intensity as 0.72 mole of sodium nitrite. The rates of the two reactions are probably affected differently by temperature changes, but no provision is made in the instrument for maintaining constant temperature.

Dynamic calibrations are made using synthetic mixtures of nitrogen dioxide and filtered air contained under pressure in stainless steel cylinders. The gas mixture is manually admitted to the instrument while grab samples are removed from the stream at frequent intervals for analysis using the Griess-Ilosvay procedure[7]. In this method all of the nitrogen dioxide is converted into nitrous and nitric acids before the dye-forming reagents, sulfanilic acid and 1-naphthylamine are added. The theoretical equivalence of one mole of nitrogen dioxide to 0.5 mole of sodium nitrite is assumed to prevail, although there is some question about this. No attempt has been made to calibrate the instrument specifically for nitric oxide. Preliminary investigations have shown that as long as the excess ozone remains below 1 ppm, no reaction between ozone and azoamine, to form the yellow azoxy compound, occurs. An ozone to nitric oxide ratio of 1.1 is sufficient for instantaneous and complete conversion of the nitric oxide to nitrogen dioxide.

The instrument is zeroed by automatically cutting off the air and ozone supply once per day. As blank reagent continuously flows through the reference cell, adjustments need be less frequent than with the oxidant recorder. Zero adjustments are manual by means of beam attenuators in all three light paths.

Currently, the reagent is not recycled but the possibility of doing this is being investigated. By filtering the spent reagent through a carbon filter, the colored product and the coupling agent can be completely removed. The reagent may be regenerated by the addition of fresh coupling agent, except that after about three or four cycles a significant amount of the sulfanilic acid has been absorbed, and the acetic acid concen-

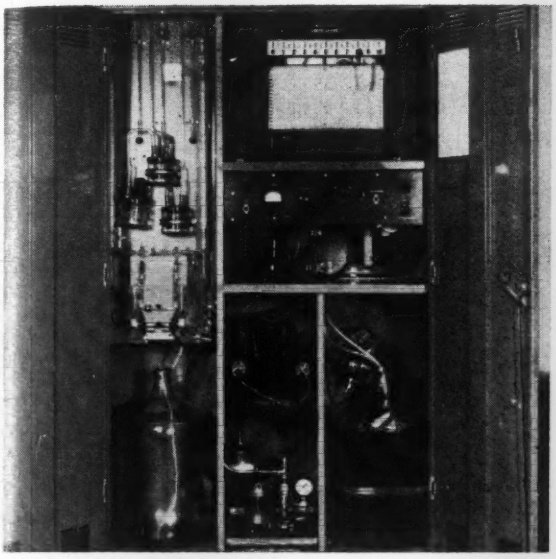

Fig. 6. Borman recorder for nitric oxide and nitrogen dioxide.

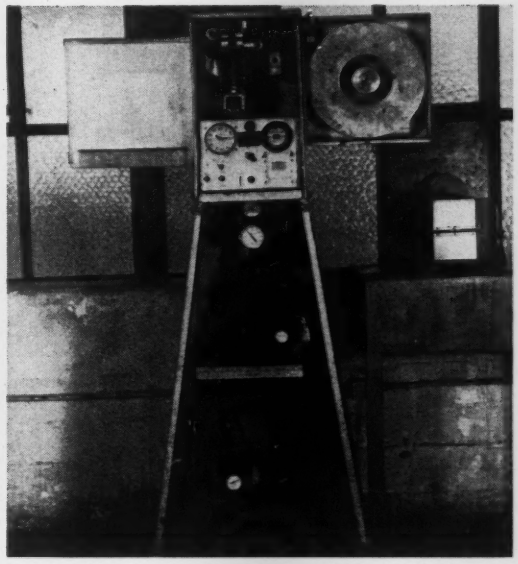

Fig. 7. Automatic sampling device for particulate matter.

tration has been reduced through evaporation.

Owing to the low liquid rate through the column, and the fact that there is insufficient air to disperse the liquid, there is a tendency for channeling and build-up of reaction products in the column. Frequent cleaning with potassium hydroxide in alcohol reduces this tendency. Despite the fact that reagent-grade sulfanilic acid is used, some products have a grey-green color which results in a green deposit in the contact column. Recrystallization of the sulfanilic acid reduces this effect considerably. Considerable difficulty has been experienced with the instrument due to the inaccessibility of the glassware in the cabinet, lack of ready-disconnect features, and the use of specimen jars for ozonators, mixing vessels and compensating vessels. These deficiencies are being corrected by the District.

Particulate Sampler

An automatic sampling device which was developed by Hall[8] and manufactured by Albert L. Chaney Laboratories is used for sampling particulate matter (Fig. 7). Air is drawn at 25 cfh through a filter medium (Whatman 52 filter paper) which is fed on demand from a spool while a system of timers, relays and solenoids controls the collection of a succession of 57-minute samples. At present these samples are taken back to the laboratories where their albedo is measured either by a DU Spectrophotometer or a Photovolt Reflectometer. Representative samples are occasionally analyzed for metals by arc spectrography. Plans for the immediate future provide for automatic reflectance and/or transmittance measuring and recording devices on these instruments.

Ozone Recorder

The program's greatest need is for automatic ozone instrumentation. This is particularly true because it is the only known toxic material found in smoggy air which has approached the dangerous level. So far, in the District's program, rubber cracking has been the only specific ozone test used. Recently two prototype instruments based on ultraviolet absorption have been developed.

Long-light-path Ozone Recorder

The first such instrument is based on the researches of Stair[9] and was developed by the Air Pollution Foundation and purchased from Borman Engineering, Inc. (Fig. 8). It uses an 85-watt General Electric Type-Ch3 high-pressure mercury lamp as an energy source over an open sample path of approximately 250 feet. The spectroradiometer receiver contains a motor-driven cam-mounted prism which automatically scans the spectrum from 265 to 365 millimicrons and return in one cam revolution per 15 minutes. A phototube is used as the detector and, through the usual preamplifier and amplifier arrangement, the intensity of the mercury spectral lines at 265, 270, 275, 280, 289, 302, 313 and 365 millimicrons* is recorded on a strip chart. The ozone determination depends upon the strong absorption in the ozone band near 265 millimicrons and is contrasted with the almost negligible absorption at the edge of the band as represented by the 313 millimicron line.

Inasmuch as the intensity of the 313 line is so much greater than the 265 line, the instrument is provided with an attenuator which automatically cuts in and out, depending on the direction of prism rotation. In its present operation, the degree of attenuation is such that the 265 and 365 lines are brought to approximately the same reading in the near absence of ozone. To zero the instrument, a manual gain adjustment is used to bring these readings close to full scale, in the absence of any ozone.

The long light path renders it impractical to calibrate such an instrument against known concentrations of ozone. Calculations for ozone are made from chart readings of transmittance, and are based on literature values for the absorption coefficients at the two lines.[10]

The main difficulties with the instrument are its unwieldiness due to the long light path with separate source and receiver units, plus the fact that the short life of many of the source lamps leads to frequent replacement and consequent realinement of the instrument. Also,

* The lines 265, 280, 313 and 365 are the only ones germane to the analysis. The others afford a check of source intensity.

Fig. 8. Spectroradiometer receiver unit for long-light-path ozone recorder. The light source can be seen on building in the right background.

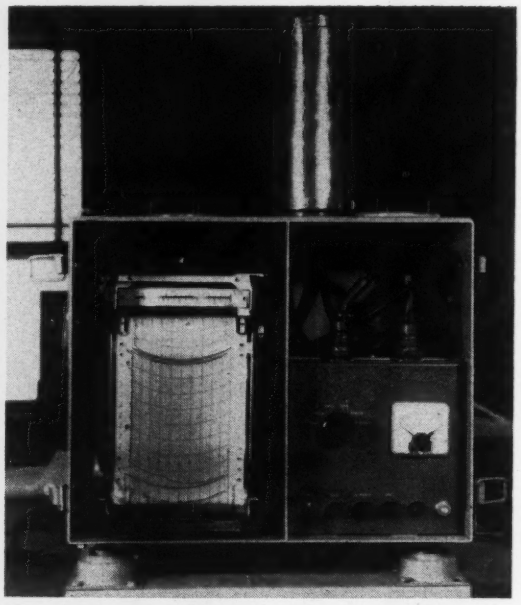

Fig. 9. Jordon recorder for monitoring background radioactivity. The ion chamber on top of the case can be remotely located.

there is no absolute assurance that the attenuation of the 265 line due to materials other than ozone is fully corrected for by an equal amount of attenuation of the 313 line. Of lesser importance is the fact that the background concentration of ozone at which the instrument zero is determined in practice is not strictly known.

Kruger Ozone Recorder

The second instrument designed to monitor ozone is one developed and manufactured by the Harold Kruger Instrument Company. It is an ultraviolet instrument of more conventional design, using 10" cells, a single source of radiation, and a double path of fixed wavelengths at 253.7 millimicrons. One cell has atmospheric air passing through it, while the other cell samples the same air with the ozone removed by catalytic decomposition. A manganese dioxide coating on the internal surface of a four-foot tube represents the catalyst.

The instrument is operated at high gain so that only 0.4% reduction in transmittance causes full-scale deflection on the recorder. In this range the optical density varies inversely with the transmittance and the ozone concentration is read directly from a linear scale.

The efficiency of the catalyst is determined manually once a week. As long as it remains active, decomposition of the ozone is rapid and about 99% complete. Because of the high gain, the instrument tends to be unstable. Therefore, provision is made for automatic zero adjustments every half hour and span adjustments every eight hours. Instrument zero is obtained while by-passing the catalyst chamber so that unaltered sample flows through both the sample and comparison cells.

Instrument calibration is based on the attenuation due to a platinum grid interposed in the path of the sample cell while the flow system is operated under zeroing conditions. Dynamic calibrations are performed using known amounts of ozone, as in the oxidant recorder.

Little difficulty has been experienced with the operation of the instrument to date, although there is some concern about the effective life of the catalyst when continuously on-stream. The specificity of the catalyst for ozone has not been fully established, and mercury vapor (which has a relatively high extinction coefficient at 253.7 millimicrons) is known to be removed by it. The prior removal of this interferent by its amalgamation with gold is being investigated; if successful it may well result in prolonging the life of the catalyst. The catalytic decomposition of other pollutants known to absorb radiation in this region, such as the aromatic hydrocarbons, both mono-and polycylic and their peroxides, is also being studied.

Summary and Conclusions

Recording colorimeters and spectrometers constitute the major portion of the gaseous contaminent measuring devices. As the field is new, much room exists for further development. Future aims include instruments which are more sensitive and which have greater specificity. Costs should be lowered and instrument size reduced. Other types of detection should be investigated .

Despite problems in instrumentation, the Los Angeles air sampling network has confirmed suspected mechanisms of smog formation, serves as a pollution build-up warning system, and is aiding plans for future development of the Los Angeles area.

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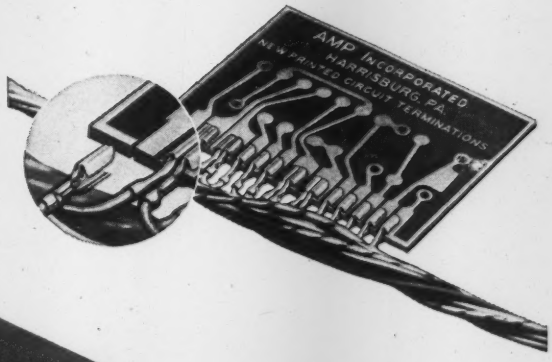

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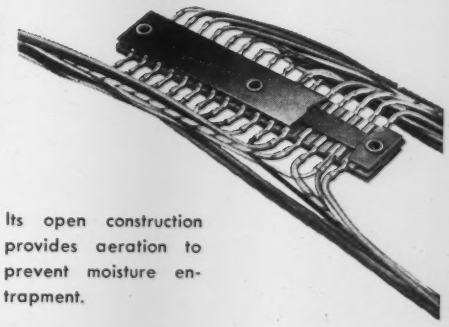

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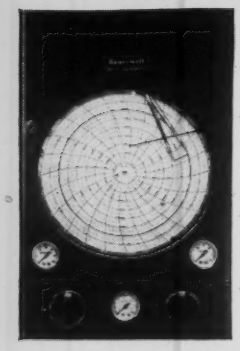

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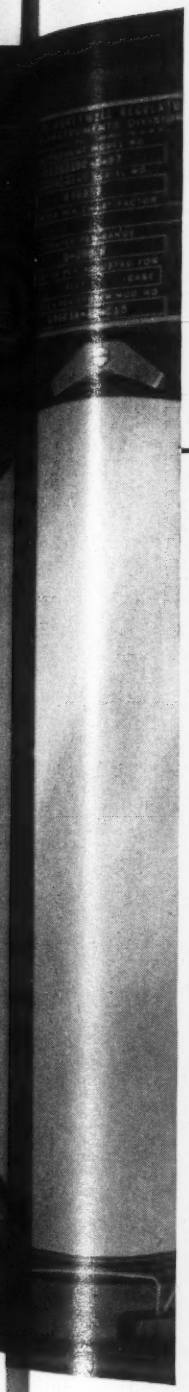

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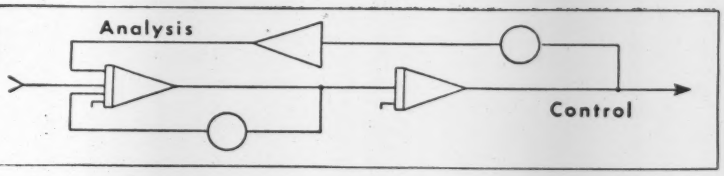
The SIMULATION COUNCIL Newsletter



John H. McLeod, Jr., EDITOR

Suzette McLeod, SECRETARY

8484 LaJolla Shores Drive
LaJolla, Calif.

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Bits

Remember, how, a few months ago, your Editor hadn't heard from the Southeastern Simulation Council for some time and so made unkind remarks about how maybe those rebels had seceded? Now the pendulum has swung the other way and we have *two* meetings to report—at Oak Ridge National Laboratory in June and the Mine Defense Laboratory in September. And in these writeups your Editor is happy to say that his neck is not sticking out very far; we have stayed fairly close to the text as sent us by *Bill Bradley*, the SSC Secretary.

Your Editor cannot say as much for the other writeup. There my neck is really way out, and I will tell you why. We had "cockpit trouble" with the electronic secretary at the Jet Propulsion Meeting of the Western simulation Council last September. Result: no tape. So the speakers at the meeting (a panel discussion on the subject. "How Do You Know You're Right?") were offered a rare opportunity, that of telling us in writing not what they really said, but what they wish they had said. All but one responded nobly with summaries of their remarks. (The exception apparently would rather have forgotten the whole matter; we are told he got sick when reminded of our request!)

The writeups showed what had not been particularly apparent in the panel discussion, that three of the five described systems of checking had more points of similarity than of difference.

This puts ye Ed. on the well-known horns of D. If we quote verbatim we take up a lot of Milt's space—and of your time. On the other hand, if we try to summarize and compare these rather complex systems your Editor is bound to be off-base somewhere.

So what do I do? I take my chances of incurring the wrath of the vendor who feels himself slighted*, so if you care about "How Do You Know You're Right?" in analog simulation, read on. But bear in mind that more will come in the future when we have to publish corrections, omissions, etc.

*At least one of my friends has found this is the best way to get free advertising, so I am not really too afraid of hurting anyone permanently! We also give free advertising if:

1. We believe that the advertiser is disclosing an advance in the state of the art.
2. We feel that the information will contribute to a better understanding of the equipment or techniques of simulation. . .
3. We think that readers will be interested or amused.
4. We give an equal opportunity to all vendors (as we did in this case).
5. We are tricked into it!

Pieces

SOUTHEASTERN S/C MEETING OF 22 JUNE 1956

The Southeastern Simulation Council held an all-day meeting on June 22nd of this year at Oak Ridge National Laboratory in Tennessee with Union Carbide Nuclear Company of Union Carbide and Carbon Corporation as host. (Seems they operate the Lab.)

The morning tour featured laboratory application of analog equipment to simulate operation of a reactor-power system; the ORACLE (Oak Ridge Analytical Computer and Logical Engine)* and electronic computing system; and two operating reactors.

*This reminds us of a letter sent to your Editor by Dr. Philbrick which said, among other things: ". . . in the case of the classified project TIGER. This was originally a random choice of letters forming a pronounceable word and a clever man subsequently decided that they stood for 'Terribly Intelligent Group Except Ralph'."

This laboratory, which also studies nuclear phenomena by means of particle acceleration, is equipped with two principal types of accelerators: (1) Units in which the high-voltage electric charge is produced by a transformer system, capable of charges to 3.4 MEV; and (2) Units of the Van de Graaff type capable of producing charges to 6 MEV.

The ORACLE is used to perform extensive calculations quickly. With four banks of computing equipment in addition to console and readout, it can perform operations involving long and short memory, arithmetical manipulations, and curve plotting.

The "loading face," control room, and environmental cavity of the graphite reactor were included in the Council's tour (see illustration). This installation was originally designed as a pilot plant to check out the system, to be used at Hanford, Washington; currently it is used to produce radioactive isotopes and to conduct biological experiments. The power rating has been increased from the original design objective of 1 megawatt to 3.8 megawatts.

The group also saw a "swimming pool" reactor—a relatively inexpensive reactor which should be ideal for university and commercial research activities. The operating level can be set from 1 watt to 1 megawatt.

The analog-computing equipment was set up to train a reactor operator. A simulated control console feeds command signals into the computer, while the dynamic characteristics of the reactors are simulated by the computer. Operating outputs are displayed on strip chart records.

In the technical discussion which took place during the afternoon, *Steve Hanauer* (Oak Ridge National Laboratory) told about an application of analog computers to the design of control systems for nuclear reactors. He stressed the importance of surveying reactor characteristics by simulation as a necessary safety consideration.

Lee F. Burns (Arnold Engineering Development Center, Tullahoma, Tenn.) described an application of the analog computer to the design and operation of a pressure and flow control system for air in an aircraft jet-engine test facility. The facility was designed to control air pressures to a simulated altitude of 80,000 feet and to a flow rate to simulate air speed of Mach 2.

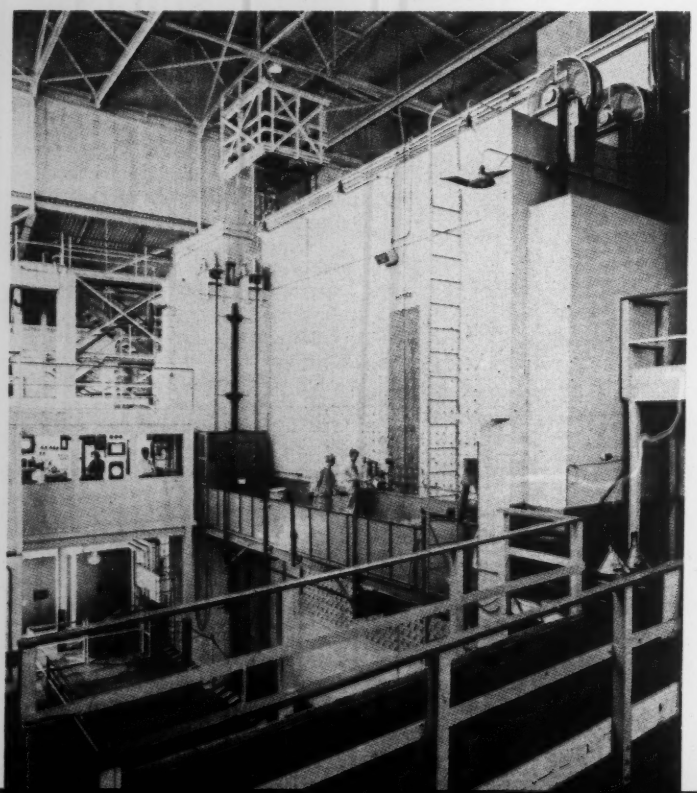
John K. Flora and *F. T. Sawyer* (Alabama Automation Corp., Huntsville, Ala.) discussed a new "curve follower" type of function generator which was developed specifically for programming a high-temperature system to simulate the heating effect of high-velocity air flow on wing sections.

R. E. Jones (Oak Ridge National Laboratory) described a time delay or "transport lag" simulator* using capacitor-charging and voltage-sensing through ganged commutators separated by a variable arc to give the desired time delay. He also told about a circuit for "dead band" effect which uses two diodes back-to-back. (Diode backlash circuit?—Ed.)

Dave Prince (Georgia Institute of Technology, Atlanta) discussed applications of the analog computer in their laboratory which involve accurate resistor measurement and fabrication, and use of transistor diodes back-to-back for amplifier limiting.

Final speaker on the program was *J. W. Henry* (Tennessee-Eastman Company, Kingsport, Tenn.) who presented problems in the chemical industry which they hope to solve through analog-computer simulations. Specifically, he mentioned problems in the dye-making industry and ways of optimizing chemical reactor plants using catalysts.

The Oak Ridge National Laboratory's uranium-graphite reactor is the oldest continuously operating nuclear reactor in the world, and the second oldest in man's history. It is currently the world's largest producer of radioactive isotopes for research in the fields of biology, medicine, agriculture, industry, and many others.



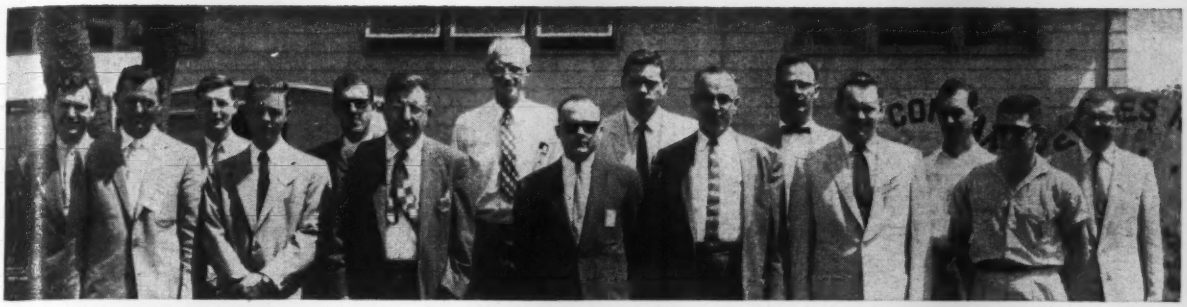
SOUTHEASTERN S/C MEETING OF 14 SEPTEMBER 1956

The Southeasterners had another all-day meeting on September 14th at the Mine Defense Laboratory in Panama City, Florida. The morning was taken up with a tour of laboratory buildings and facilities.

The technical session in the afternoon was opened with remarks by *Bill Bradley* (Secretary and Acting Chairman of the SSC), *Dick Waddey*, and *Captain J. C. Myers* (Mine Defense Laboratory).

The first speaker was *Dave Prince*, whose subject was "Some Solutions by Analog and Digital Means." Dave talked about which type of computer to use under what circumstances, and covered the following points: (1)

*Note Eastern Simulation Council Meeting of 29 November 1956: "Simulation of Time Delays."



Reading from left to right, Mr. Ed Holmes, Southeast Industrial Instru., Mr. Dick Waddy, USN Mine Def. Lab., Mr. Gil Knollman, Ga. Tech., Mr. T. K. Wright, Ga. Tech., Mr. T. D. Shockley, Ga. Tech., Dr. John W. Cell, N. C. State Univ., Dr. A. L. Bennett, USN Mine Def. Lab., Bill Bradley, Murphy and Cota, Mr. Grady Cox, AFAC, Eglin AFB, Dr. G. B. Findley, USN Mine Def. Lab., Mr. W. G. Thornton, Redstone Arsenal, Mr. H. M. Ireland, Ga. Tech., Mr. John Tedesco, Tyndall AFB, Mr. Dave Prince, Ga. Tech., Mr. Edward C. Allman, AFAC, Eglin AFB.

Ease of spotting error on digital; (2) Ease of pot manipulation on analog; (3) Costs—usually a good deal higher on digital equipment; (4) Speed—Analog about 10 times as fast for some typical problems; (5) Accuracy—Digital in most cases giving a more precise solution.

Dave then discussed a method of performing integration over the surface of a sphere by fitting a spiral of several hundred revolutions around the surface.

E. C. Allman (Eglin Air Force Center, Florida) gave a brief description of their equipment and future plans. Their primary objectives are: (1) To use the analog simulator to reduce the load on digital data-reduction equipment, and (2) to reduce the amount of actual flight-testing of components and equipment. Ed also discussed their training program for operation of the analog equipment. They plan to use the analog as an engineer's "Do It Yourself" kit.* At present they are giving a beginners' 30-hour course, to be followed by a graduate one.

Cell on Basic Math

Dr. John W. Cell (University of North Carolina, Raleigh) discussed the "Solution of Differential Equations by Analytical and Computational Methods" and made a plea to call computers giant morons** instead of giant brains in order to emphasize the importance of mathematics in education at all levels, especially high school.

As an example Dr. Cell used the following equations encountered in spinner rocket studies:

$$\frac{d^2y}{dx^2} - \left[\frac{1}{x} + i\,4\pi\,(x+\lambda)\right]\frac{dy}{dx} - \frac{4\pi^2x^2y}{s} = 0$$

$$W = \int_{x_o}^{x} \frac{y}{x^2}\,dx$$

This set of equations can be transformed into the following set:

$$\frac{d^2y}{dr^2} - i2\pi\left[1 + \lambda r^{-1/2}\right]\frac{dy}{dr} - \frac{\pi^2}{s}y = 0$$

$$W = \tfrac{1}{2}\int_{r_o}^{r} r^{-3/2}\,y\,dr$$

The question requiring mathematical judgment is whether to solve these in the x or r form, and whether to obtain solutions by analytical, analog, digital or other means.

The problem can be solved analytically and the solution obtained in closed form in terms of confluent hypergeometric function,* but these functions are not tabulated; therefore solutions would be time-consuming and difficult by this method.

Solutions by digital methods would involve use of analytical solutions. Because of the nature of the problem, the time required for digital solution becomes exceedingly large.

The substitution $Z = \sqrt{r}$ was made in the second of these equations to avoid division in the analog equipment. To get accurate solutions on the analog computer it was necessary to use an automatic scale changer (to insure optimum operating points) and to use pseudo forcing functions (to cancel errors arising in the computer).

Other means might include dreaming up a physical model or using some methods of simplification. For example, if x could be considered constant over a short range, using the mean value of x over this range would simplify the first set of equations to second-order differential equations with constant coefficients. These equations could then be solved.

Dr. Cell emphasized that one should not choose a particular method before investigating a variety of possible methods of solution. A comparison of solutions should be made to determine the precision of each method; then the particular method of solution can be chosen which best fits any given situation as to time, cost, accuracy, etc.

*Oh!

*In filing that remark in the "wish I'd said that" department.—Ed.

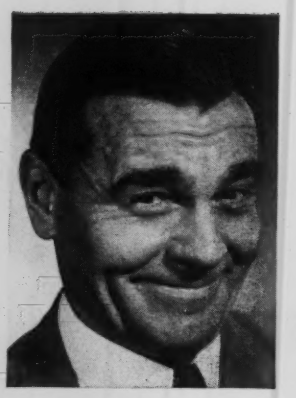
**See last month's "Thot" by Bill Schart: "The analog computer is a bunch of morons with hoses transferring water from tank to tank."

WESTERN S/C MEETING OF 13 SEPT. ON "HOW DO YOU KNOW YOU'RE RIGHT?"

About 63 representatives of 31 organizations attended the meeting of the Western Simulation Council at the Jet Propulsion Laboratory (California Institute of Technology, Pasadena) September 13th.

For the occasion *Jack Sherman* (Lockheed Missile Systems Div., Palo Alto, Calif.) organized and moderated a panel discussion of that omnipresent question of simulation; "How do you know you're right?"

Sed Atwood (Convair-San Diego, Calif.), *R. C. Schmidt* (Berkeley Scientific Division, Beckman Instruments, Richmond, Calif.), *Hank Flum* (Reeves Instrument Corp., Santa Monica, Calif.), *Bob Turner* (Lockheed Missile Systems Division, Sunnyvale, Calif.), and *Norm Irvine* (Mid-Century Instrumatic Corp., Los Angeles) made up Jack's panel.



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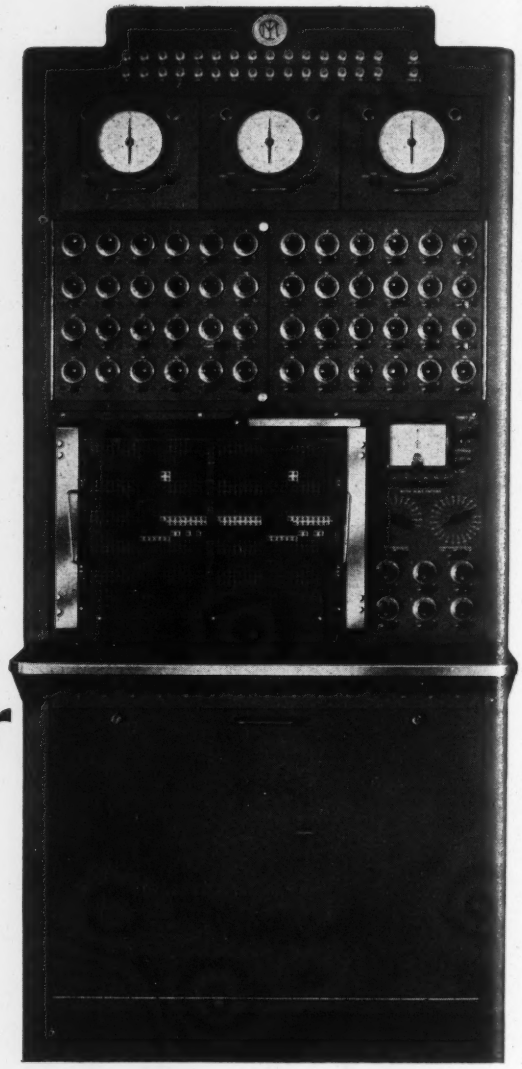

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Turner on the Basic Problems

Bob Turner, in response to our request, has helpfully summarized his remarks as follows:

"*How do you know when you're right?*" We have found that this provocative question has two parts:

1. Do you and/or the customer (the person for whom the work is being done) know the right question to ask the computer; i.e. is the problem correctly formulated?

2. Have you asked the computer the problem you *think* you have? (An incorrect wiring setup would cause the wrong question to be asked.)

The first of these questions may be considered outside the province of the computer engineer; however, for those of us who have paid the penalty for blindly putting on a customer's problem without even a cursory examination of the physics of the situation, the point has merit. Should you belong to this school, a helpful motto born of experience might be, 'The Customer Is Seldom Right."

Having now alienated all potential customers, let us proceed to the second question. At this point it is of the utmost necessity to realize that equation sheets are the Bible; whatever question we are *actually* asking the computer, we *think* we are asking it to solve the problem posed on the equation sheet. (We have found it exceedingly helpful to work with the customer, for he should be able to tell whether or not a solution is good, and if not, in what way or ways.)

Assuming that a solution is in doubt, we may perform the following checks. Both mathematically and diagrammatically many problems consist of groups of closed loops with so-called cross-coupling terms. With cross-coupling out, disturbing the loops internally will generally give characteristic frequencies and damping rates. Perhaps the customer can supply these, for it is probable that these loops comprise the building blocks of his system. For simple loops, pencil and paper analysis will readily give these desired characteristics. For larger loops, or loops connected by the cross-coupling terms, the task is more difficult.

For example, using Laplace transform techniques, the equation of a group of linearized loops will yield the form:

$$\theta_o(s) = \frac{\sum_{j=o}^{n} a_j s^j}{\sum_{j=o}^{N} b_j s^j}, \quad N > n$$

This form is easy to obtain, but the labor required for root extraction and the subsequent algebraic manipulation necessary to interpret the result in the time domain is appalling. However, root extraction and algebraic manipulation are made to order for digital computers. So, at our request, the Digital Group coded a routine to evaluate $\theta_o(t)$, given $\theta_o(s)$ as written above. An arbitrary limit of 10 was chosen for N. As it is highly desirable to plot this digital solution for the first few seconds in order to compare it with traces obtained from the analog computer, the routine evaluated $\theta_o(t)$ at various fractions of a second and the results were plotted automatically. Since these digital operations are very fast the plotted answer may be available, say, in less than one-half hour, even for polynomials of higher degree.

Though we have not had to resort to this routine often, those few times we did were of immense value in determining whether we were right or wrong.

* * *

Review of Other Comments

Hank Flum (Reeves Instrument Corp., New York, N. Y.), *Chuck Single* (Berkeley Scientific Division, Beckman Instruments, Richmond, Calif.) and *Sed Atwood* (Convair-San Diego) also responded to my plea. It seemed to me that these vendor's systems and Convair's were quite similar in principle, if not in detail, to each other and also to the equipment of some vendors who were invited but were unable to participate in our panel discussion.

From where I sit (or lie—Suzy and I are reclining in our patio in the warm mid-November California sun) it seems that all vendors are basically mechanizing two types of checks—static and "dynamic."

In the *static check* the feedback capacitor of all integrators is paralleled with a resistor which makes them effectively summing amplifiers, and the outputs are disconnected from the following amplifiers which are connected instead to an independent voltage source. This accomplishes several things: (1) It allows the correct outputs of the amplifiers to be calculated from the known inputs and compared with the measured outputs; (2) it breaks up the problem, which might have contained obscure closed loops, into smaller parts which can be easily analyzed to localize errors; and (3) it facilitates "signal tracing" by the appearance or absence of a voltage at other points in the system.

In the *dynamic check* the integrator outputs are still disconnected from following computer components, but the inputs are connected to selected voltages for a carefully controlled length of time. This allows the time constant of the integrators to be checked.

Stan Rogers (Convair-San Diego) feels, and I am inclined to agree with him, that:

1. The "dynamic" check is not a dynamic check.
2. There is little need for it, whatever it is called.

It is not a dynamic check because it does not check the dynamics of the problem setup, but only the time constant of the integrators. This is important, because some vendors do offer a true dynamic check in which they double the feedback capacitance so that the whole simulation operates at half speed. If there is then any difference in the solution it is an indication that the dynamic capabilities of some of the components were being exceeded in the original setup.

There is little need for checking the time constant because that is a function of components which are checked in the static check plus the feedback capacitors, which seldom fail.*

There are, of course, many variations in the way the checks are accomplished.** For instance *Sed Atwood* at Convair uses a card reader to select one of several available input voltages for each amplifier, and a Clary printer to record the outputs. Reeves, on the other hand, selects input voltages by means of a potentiometer and uses a Flexowriter to record the outputs. Reeves, Goodyear, Berkeley, Electronic Associates, and others have their own variations, but for the most part they seem to your Editor all to be simply varying

*Stan says that they checked 550 capacitors after they had been in service six months and found that 30 had drifted somewhat. They were trimmed up and not one has given trouble since. That was three-and-a-half years ago.

**However, there is no variation in one thing: all the vendors (and some of the users for that matter) claim that their system is the first to make such checks possible.

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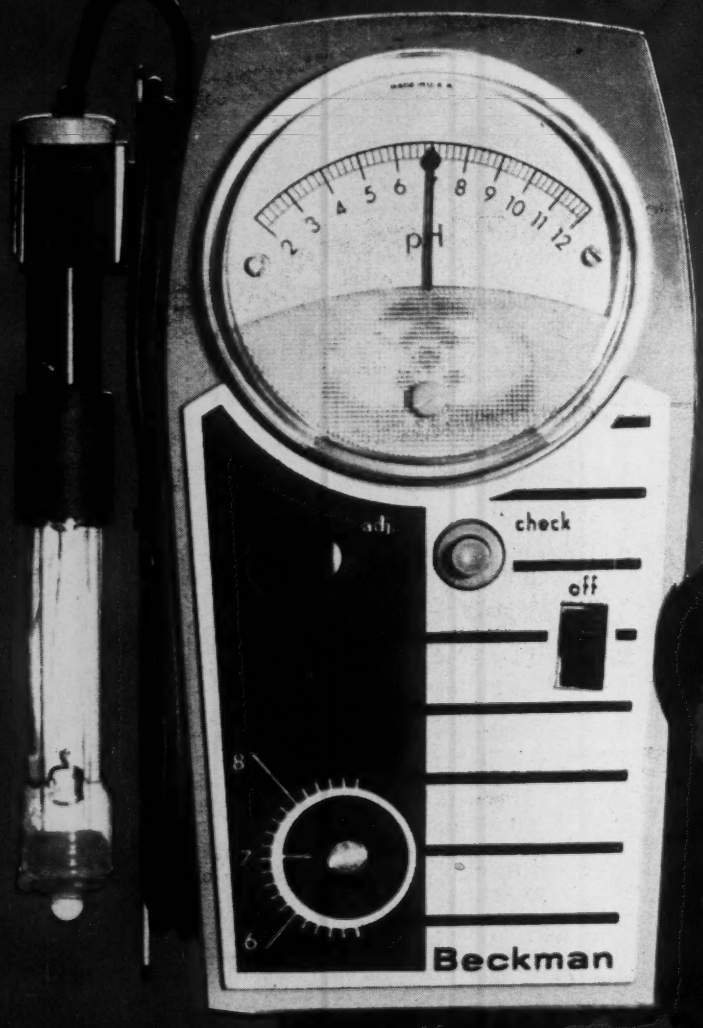

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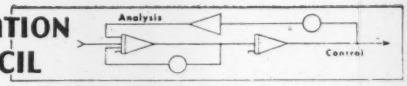

mechanizations of the same basic ideas.

There are undoubtedly exceptions. For instance, Electronic Associates puts a switch between the summing junction and the integrator input and then supplies an initial condition adjustment such that the amplifier output can be used as an input to following components, corresponding to the Convair method of supplying these inputs from pre-selected voltages and Reeves from pot-setting. In other words, EA is using the integrator as a current source for following components. As a method of supplying an input into these following components this has advantages and disadvantages. However, there is one other feature of this system worth consideration. Because the switch breaks the circuit between the summing junction and amplifier and connects the summing junction to a readout amplifier, it gives a measurement of the input to the integrator, i.e. the derivative of the integrator output. When you consider that these switches can be operated independently, and that therefore the derivatives can be measured independently, this system seems to have merit.

However, as *Chuck Single* explains, all the systems have a common shortcoming in that "One of the major sources of analog computer error, that of going from the original system of equations to the computer problem mechanization, of course has not been eliminated." Lest this sound like a sour note, it should be borne in mind that as Chuck also observed, "The simplified technique used in these checks allows preparation of the predicted static and dynamic check voltages and the running of the check by technicians, which frees the engineer from the routine task of confirming the correctness of the problem setup."

Irvine Concludes

Norm Irvine summed up the panel discussion with a few well-chosen words to the following effect:

"How do you know when you're right? It isn't often that you do know when you're right unless you're so fortunate as to have test information that can be duplicated in your simulation. Cross checks between digital and analog solutions tell you that you are solving the *same* problem, but it requires a good engineer to determine how near you are to solving the *right* problem.

"Most simulation equipment has techniques for static checks and point checks which help to determine whether you are solving the problem you think you are. Switching systems are available to check integrators and other equipment, but this does not answer the question directly.

"Depending upon the problem, certain dynamic checks can be made by comparing frequency and transient responses between a hand or digital computation and your simulation. Even then, however, a good engineer is required to determine the *validity* of the tests and the effects of nonlinearities. Certain error analyses may be applicable, but these are generally lengthy and laborious and all too often will get you off on Cloud Nine where you don't have your feet firmly planted in the realm of reality.

"In short, I believe there is no substitute for a good engineer. The computing and simulation equipment are powerful tools but they cannot tell you when you are right."

Computer Events

Other events on page 2380

DDA Council

Date: 15 January 1956
Place: IAS Building, 7660 Beverly Boulevard, Los Angeles, Calif.
Time: 9:30 AM
Talk by Raymond Elliott (Convair-San Diego Computer Laboratories) on "The ABC's of DDA's", followed by discussion.
Time: 1:30 PM
Panel discussion of the application of DDA's, "What Are DDA's Good For?" led by Jack Connolly (Litton Industries).
There will be a combined general-purpose Bendix computer and digital differential analyzer on display at the meeting.
Further information can be obtained from Stan Rogers, 3023 Alcott Street, San Diego, Calif. or Max Palevsky, Bendix Computer Division, 4730 Arbor Vitae, Los Angeles, Calif.

Western Joint Computer Conference

Dates: 26-28 February 1957
Place: Hotel Statler, Los Angeles, Calif.
Subject: "Techniques for Reliability"

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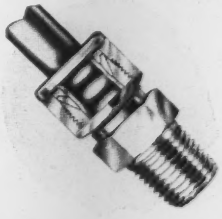
FITTINGS



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CRAWFORD FITTING CO.
884 EAST 140th STREET
CLEVELAND 10, OHIO

For more information circle 65 on inquiry card.

Typical Bishop Thin Wall Tubing

Whether it be for an hydraulic line in a jet engine . . . a precision part for a scientific instrument . . . wherever there is a need for corrosion or abrasive resistance, or where workability or stress are involved, you can *depend* on BISHOP stainless steel tubing.

Where close tolerances, accurate specifications are to be followed . . . when clean I.D. and O.D. are important factors, look no further for quality, specify BISHOP stainless steel tubing—at comparable prices.

Platinum and Platinum Group Metals
Stainless Steel Tubing
Tubular Fabricated Parts
Spinnerettes

CAPILLARY, MECHANICAL, HYPODERMIC and AIRCRAFT
Stainless Steel Tubing—seamless and welded and drawn
(.008" to 1.000" O.D.)
(.003" to .083" Wall)

NICKEL AND NICKEL ALLOY TUBING
(up to .625" O.D.)
Flanged, Flared, Milled, Slotted, Swaged, Threaded.

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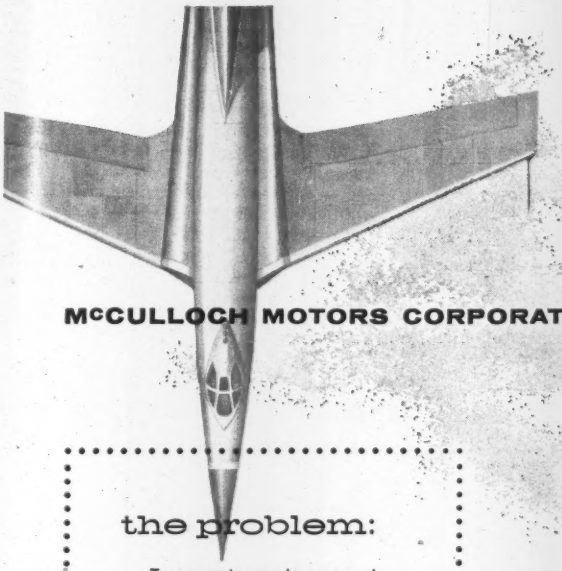
STAINLESS STEEL PRODUCTS DIVISION

J. BISHOP & CO. Platinum Works

Malvern, Pennsylvania

For more information circle **83** on inquiry card.



McCULLOCH MOTORS CORPORATION

saved 2899 engineering manhours with a Bendix G-15 computer!

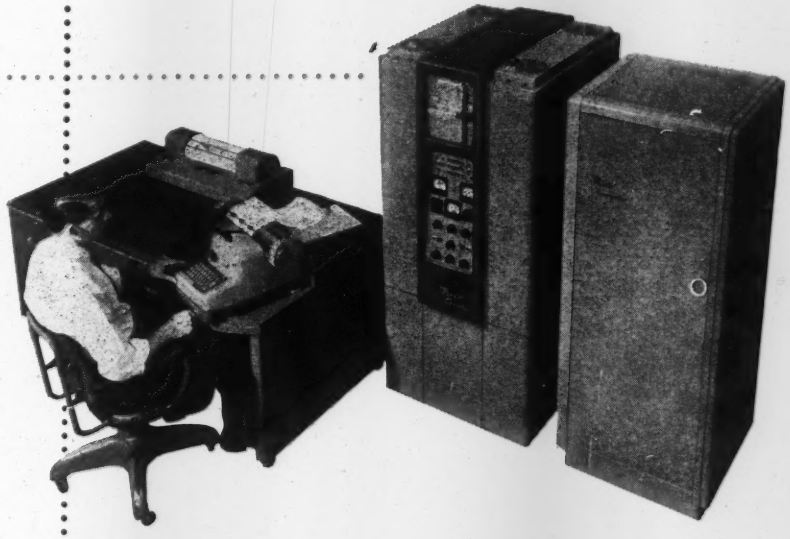
the problem:

To compute nozzle area, net thrust and fuel consumption for a new turbine design. 729 sets of answers were required, due to problem variables.

solution:

This problem was essentially unsolvable by conventional methods. The 729 sets of answers would require 2916 manhours on the slide rule, or 10 valuable engineers or mathematicians working for 36 days.

Including programming and check-out time, only 17 hours were required to obtain the 729 sets of answers when McCulloch turned the problem over to the Bendix G-15 General Purpose Digital Computer. **The solution was obtained by one man** and the chance for human error was greatly reduced. But most important, **the engineering time saved was 2899 manhours**... 171 times less than conventional methods. The same type of problem could be solved again in five hours.



New G-15 programming methods suit both the engineer with an occasional problem and the experienced programmer. The INTERCOM system can be learned in just a few hours. As a bonus, an inexpensive accessory adds digital differential analyzer capabilities to the talented G-15. The coupon will bring you further details on the G-15's ability to conserve scarce engineering manhours in a wide range of applications.

Bendix Computer

DIVISION of BENDIX AVIATION CORPORATION

OFFICES IN WASHINGTON, D.C., DALLAS, AND LOS ANGELES

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BENDIX COMPUTER DIVISION—BENDIX AVIATION CORPORATION
5630 ARBOR VITAE STREET, LOS ANGELES 45, CALIFORNIA

Please send me more details on your Model G-15 General Purpose Digital Computers.

NAME_____

TITLE_____

COMPANY_____

ADDRESS_____

For more information circle **66** on inquiry card.

INSTRUMENTS and AUTOMATION

New Instruments

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Acceleration 2457
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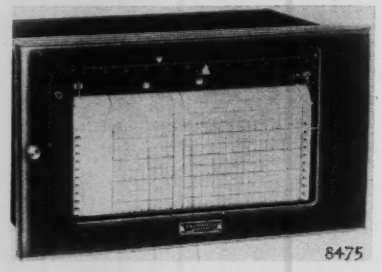
FOR FURTHER INFORMATION USE THE POSTAGE-FREE ORDER CARD ON PAGE 2521

PROCESS MEASUREMENT and CONTROL

RECORDING POTENTIOMETER

New two-pen 11" recording potentiometer (12" paper width) supplements maker's line of 5" miniature recorders; features a 3-speed Selsyn motor chart drive which provides 1",


8475

2", or 5" of chart travel for 100 turns of Selsyn, or synchronous motor chart drives to provide standard chart speeds. Other features: Pen speed 2½ sec for full-scale travel on each pen; null-balance system with continuous electronic standardization; ranges of 10 mv or greater; 0.1% sensitivity; 0.25% accuracy.—*Westronics, Inc., 3605 McCart, Ft. Worth, Texas.*

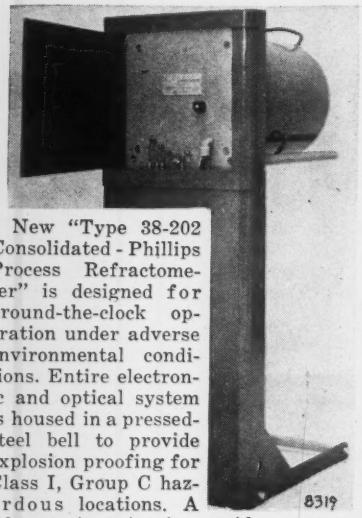
For more information circle **201** on inquiry card.

VAPORIZER REGULATOR

New "Type 38-001 Consolidated-Phillips Vaporizer Regulator assures vaporization and permits pressure control of liquid samples being introduced into analyzers and other petrochemical-monitoring instruments. Maximum inlet pressure 150 psi; outlet pressure 0 to 50 psi held constant within 0.1 psi when upstream variations do not exceed 10 psi. Maximum steam pressure 50 psig.—*Consolidated Electrodynamics Corp., 300 North Sierra Madre Villa, Pasadena, Calif.*

For more information circle **202** on inquiry card.

PROCESS REFRACTOMETER


8319

New "Type 38-202 Consolidated - Phillips Process Refractometer" is designed for around-the-clock operation under adverse environmental conditions. Entire electronic and optical system is housed in a pressed-steel bell to provide explosion proofing for Class I, Group C hazardous locations. A telemetering circuit provides a servo signal for strip- or circular-chart recording, or for automatic control.—*Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.*

For more information circle **203** on inquiry card.

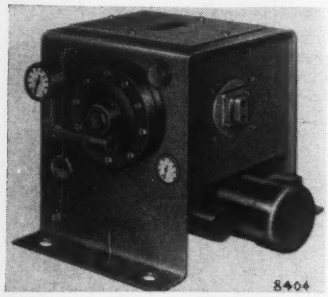
INSTRUMENT ATTACHMENTS

New sets of standard attachments for maker's "Dynamaster" instruments make available apparently-special model instruments for particular applications, at reasonable cost. Among attachments: Speed shift for chart drive allowing operator to "spread out" his chart record when he wants to, by a factor of 10, 30, or 60, by throwing a switch. Solenoid-operated pen lifter allowing instrument to be used as indicator while setting up test, then dropping pens onto chart when test starts. Range, span, and zero-adjusting devices making it possible to change range or suppress zero on an intsrument, either in definite steps or continuously. Additional time, target, and limit pens for strip-chart models making it possible to correlate time of variations in value, and to set limits on the value being recorded. Telemeter receivers; vacuum tube fail-safe; manual rewind; continuous ink feed; etc.—*The Bristol Company, Waterbury 20, Conn.*

For more information circle **204** on inquiry card.

LIGHT-DUTY EDGE GUIDE

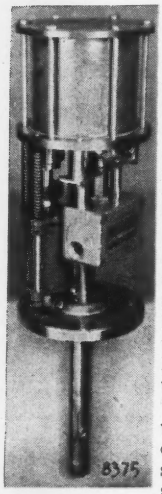
New "Model 550" improved edge guide unit, for light-duty service, is more compact than model formerly


8404

available for this service. It comprises a self-contained regulator, motor, pump and oil supply which make it much easier to install.—*Askania Regulator Co., 240 East Ontario St., Chicago 11, Ill.*

For more information circle **205** on inquiry card.

PROCESS VISCOSIMETERS


8375

New "Models M7, M8, M9 and M10 Electric-Pneumatic-Viscometer Measuring Elements" operate on basic falling-piston principle: Air-lifting mechanism raises piston assembly, drawing in sample through tube openings. Sample passes down through clearance between piston and inside of tube into space formed in lower end of tube when piston is raised. Lifting mechanism is then quickly lowered. Time required for piston to fall to bottom of tube (expelling sample out through same path as it entered) is a measure of viscosity. Illustrated: explosion-proof model for pressures from vacuum to 100 psig (readily modified for higher pressures). Particularly suitable for reactors: complete viscosity information during polymerization, etc.; also appliable to pipe lines. Ranges 0.1 to 1,000,000 cp.—*Norcross Corporation, Dept. N45, Newton 58, Mass.*

For more information circle **206** on inquiry card.

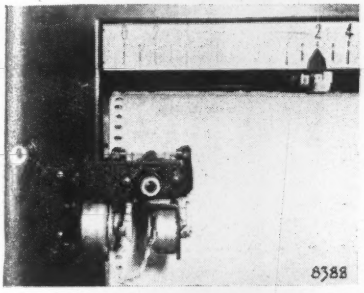
INFRARED ANALYZER

New "Model 200" of maker's "LIRA" electronic infrared analyzer is designed to fill need for a moderately-priced instrument for most continuous-flow chemical analysis problems. Unlike "Model 100," it analyzes for only one component. Like its earlier counterpart, however, it provides instantaneous analysis of flowing chemicals with an accuracy that can be duplicated by chemists only after hours of careful lab work. Accuracy of measurement is the same in both instruments, 1% of full-scale, and new model has a much higher speed of response.—*Mine Safety Appliances Co., Pittsburgh 8, Pa.*

For more information circle **207** on inquiry card.

COUNTER-PRINTER

New "Model RI-4 Identichart" is a novel device that automatically counts and then at some particular



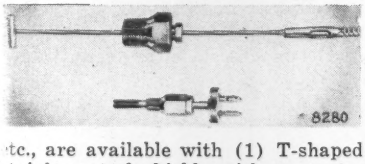
time prints the count. It can be caused to print at regular intervals so that, when reviewing the chart, user will know number of counts in any particular time period. It is said to be "ideally suited for a print-out device for integrators." Mounting can be provided for all popular makes of recorders, or unit can also be supplied by itself for printing on a card or adding machine tape. It can be supplied with as many as 8 digits for maximum count of 100 million.—*Royson Engineering, Hatboro, Penna.*

For more information circle **208** on inquiry card.

TEMPERATURE

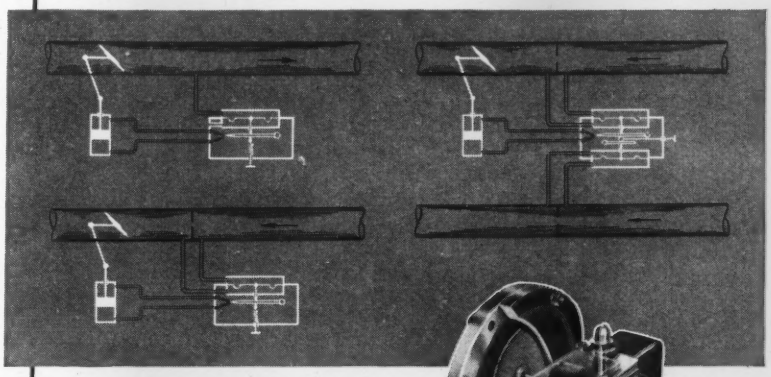
MINIATURE SHIELDED TCs

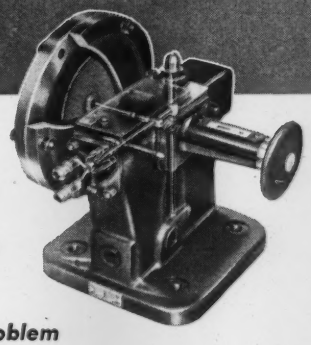
New small light-weight shielded thermocouples, for accurate temperature measurement of gases, vapors,



etc., are available with (1) T-shaped stainless steel shields with two open ends to minimize radiation losses to cooler side-walls of gas passages; (2) linen Bakelite open-end shields to prevent condensation on hot junction thus eliminating wet-bulb effect. Cali-

THE "Jet-Pipe" AGE IS HERE...
FOR PRESSURE, FLOW, COMBUSTION OR RATIO CONTROL





and so is the
ASKANIA
Jet-Pipe Regulator

...the simplest accurate long-life solution to any regulator problem

• Check your most desirable specifications for the IDEAL regulator to control pressure—flow—combustion—proportion—other variables.

Do they include

1 Rugged Construction **2** Dependability **3** Long Life **4** Accuracy **5** Speed **6** Inexpensive Maintenance **7** Unimpeded Operation in Freezing Weather **8** Freedom for use ANYWHERE?

All these features are common to all ASKANIA Jet-Pipe Regulators.

From Minute Signal to POWERFUL FORCE

The real magic behind the Jet-Pipe Regulator is the power which can be initiated by a minute signal—the degree to which the signal can be amplified—and the speed and accuracy with which it can be transmitted. The conversion of kinetic energy (velocity pressure) into potential energy (static pressure) is an important factor which multiplies the dependability you can expect in every ASKANIA control. The heart of ASKANIA Regulators—the Jet-Pipe—is practically frictionless. Bearings are continuously immersed in oil. Condensation and freezing are impossible. In every way, ASKANIA Regulators are designed and built for continuous, trouble free service over the years.

Applicable to these Controlled Variables:

PRESSURE (Gage, Absolute & Differential) • DRAFT • COMBUSTION • FLOW LEVEL • DEPTH • RATIO • SPEED • DENSITY • CONSISTENCY • EDGE POSITION AND OTHERS

What is your problem? For further information on the type of regulator control which best fits your operation, send today for Bulletin No. 139 and 155. Write the ASKANIA REGULATOR COMPANY, *268 East Ontario St., Chicago, Illinois.*

ASKANIA REGULATOR COMPANY

"CONTROLS FOR INDUSTRY"

HYDRAULIC, ELECTRONIC CONTROLS & SERVOS, GENERAL SYSTEMS, ENGINEERING & COMPUTER SERVICE, VALVE ACTUATORS & CYLINDERS

A Subsidiary of General Precision Equipment Corporation

For more information circle **67** on inquiry card.

FREE DESIGN HANDBOOK!

New!

72-PAGE TECHNICAL MANUAL AND CATALOG ON MICRO-BEARINGS

miniature ball bearings

If you work with miniature instrument-type ball bearings you'll find this new, authoritative publication a complete, handy source of engineering data and specification information.

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Far more than an ordinary catalog—it contains a helpful survey of factors to consider in selecting and applying miniature ball bearings—plus 60 pages of engineering bulletins covering all the aspects of bearings important to designers . . .

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NEW HAMPSHIRE BALL BEARINGS, INC.
PETERBOROUGH 1, N.H.

For more information circle **68** on inquiry card.

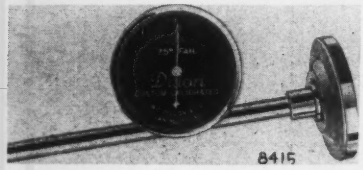
NEW INSTRUMENTS

brated in copper-Constantan, iron-Constantan and Chromel-Alumel; three temperature ranges from −300°F to 1400°F.—*Thermo Electric Co., Inc., Saddle Brook, N. J.*

For more information circle **209** on inquiry card.

SINGLE-POINT THERMOMETERS

New "Custom Calibrated" bimetallic thermometers are each calibrated at one temperature between −40°F



and 1000°F or between −10°C and 300°C as specified by purchaser. At this point, accuracy is said to be "100% absolute."—*W. C. Dillon & Co., Inc.*, 14620 *Keswick St., Van Nuys, Calif.*

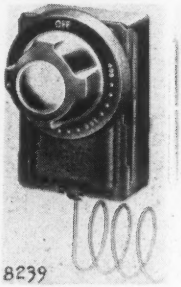
For more information circle **210** on inquiry card.

TWO-SWITCH THERMOSTAT

New "Type B27A Local Mounted Temperature Control" is a dual switch unit that can often substitute for two single-switch units. Immersion element (bellows housing) is placed into medium to be controlled; bellows plunger operates two switches. Control head has an external range adjustment with a calibrated scale. Models with range spans of 50F° or 100F° between limits of 30°F and 400°F are available. Use of two switches in one controller provides extreme flexibility of switching arrangement, permits switch action above and below set point. Internal adjustment on each switch makes it possible to adjust for a maximum zone of 20F° between switch settings, maintained throughout control range. New unit weighs 15 oz; can be mounted in any position by ½" NPT on immersion element. (Variations in thread size and manner of mounting are available).—*United Electric Controls Co.*, 85 *School St., Watertown, Mass.*

For more information circle **211** on inquiry card.

TEMPERATURE CONTROLLERS



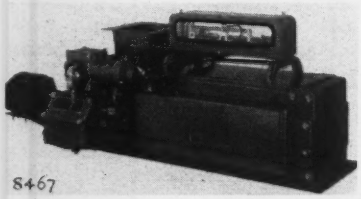
New "Series 270" of "Diamond H Thermostats" includes a wide range of models with quick action and consistent low-differential operation. Oven thermostats have UL approved rating of 25 amp, 120-240 vac; standard temperature range 200°F to 500°F (other ranges special). Two- and three-position units are available, as well as single-dial units both with or without automatic preheat operation.—*The Hart Mfg. Co.*, 110 *Bartholomew Ave., Hartford, Conn.*

For more information circle **212** on inquiry card.

WEIGHING, PROPORTIONING

CONTINUOUS WEIGHER-FEEDER

New "Merchen Pneumatic Scale Feeder," utilizing pneumatic instrumentation, is controlled by a 3-to-15-

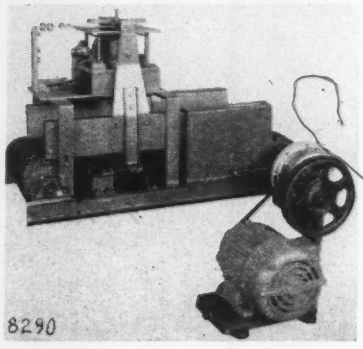


psi air signal set manually or automatically in proportion to an air signal from an external source. Feeder has a guaranteed minute-to-minute accuracy of 1% over a 3 to 3000 lb per minute feed range. Suitable for use in hazardous locations because only electrical component is a synchronous motor for driving weigh belt. Adjustable over-and-under feed alarms are available.—*Wallace & Tiernan Inc., Belleville, N. J.*

For more information circle **213** on inquiry card.

CONVEYOR SCALE

New "Unitized Weighing Belt Conveyor Scale" is a "packaged" unit with integral belt conveyor and drive assembly utilizing maker's pneumatic weight transmitter and "Uni-Force" flexure platform, eliminating errors due to load placement or pile-up. Control functions available include indicating, recording, controlling, integrating, proportioning, and programming. Performance specifications fea-

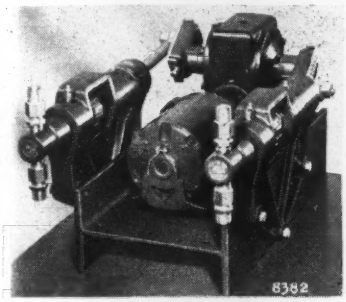


ture 0.05% repeatability and 0.02% sensitivity. Unit is unaffected by side thrust forces; has no springs, knife edges, or beams.—*Weighing & Control Components, Inc., Box 245, Hatboro, Pa.*

For more information circle **214** on inquiry card.

PROPORTIONING PUMP

New standardized "Model 1140" is adaptable to a wide range of chemical feeding applications. Plug-in reagent



end and other standardized mechanical components are readily accessible for easy servicing. Other features: new unique Vane-Guide check valves (with reversible seats) and minimum clearance volume cylinders of self-purging design; micrometer stroke-length adjustment (in-motion rate adjustment available if desired); will handle feed rates from 0.8 GPH to 900 GPH and discharge pressures to 1340 psig.—*Proportioneers, Inc., 345 Harris Ave., Providence, R. I.*

For more information circle **215** on inquiry card.

FLOW-RATE, VOLUME

FLOW-RATE INDICATOR

New "Flotometer" features corrosion-resistance and simplicity (tubes interchanged through top without dismantling); wide variety of floats; flow-rates from lab micro flows to pilot-plant throughputs; pressures to 150 psi; solvent-proof scales on tubes.—*Bayley Instrument Co., Box 538, Danville, Calif.*

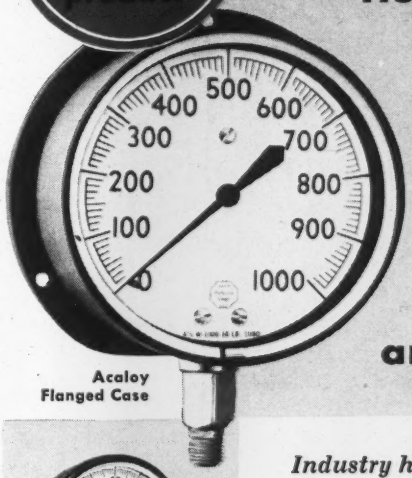
For more information circle **216** on inquiry card.

AIR-FLOW SWITCH

New "Model 955" is mounted directly on an air duct; will operate on suction or pressure as low as 0.17" up to 10" water column; can be used to shut off fuel to burners, shut off cur-

Helicoid Gages

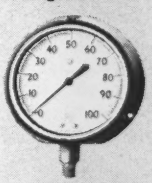
an ACCO product



Acaloy Flanged Case

Helicoid gages set new standards of enduring accuracy, trouble-free service, and economy

Acaloy Flangeless Case



Phenol Turret Case

Acaloy Flush Case

Acaloy Square Flush Case

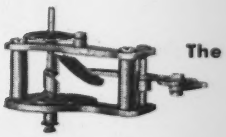
Industry has found in the HELICOID Gage, the most durable and efficient instrument ever devised to meet pressure-indicating requirements.

No Gears—No Teeth to Wear Out!
The exclusive HELICOID Movement is a simple, gearless cam-and-roller design with no teeth to wear out. It provides long and trouble-free service with a minimum of maintenance.

Sustained Accuracy—Longer Life
Because of advanced design, quality control in manufacture, and endless testing, HELICOID Gages produce more sensitive response to pressure changes. Their accuracy *endures*—even after millions of cycles.

Lowest Cost per Gage per year
These gearless gages go on performing day in and day out with little or no maintenance. This economy, together with long life, adds up to the fact that HELICOID Gages cost less per gage per year than any other gage you can buy.

Gages for vacuum and compound service. Pressure ranges up to 20,000 psi.



The Helicoid Movement

ACCO

Helicoid Gage Division

AMERICAN CHAIN & CABLE

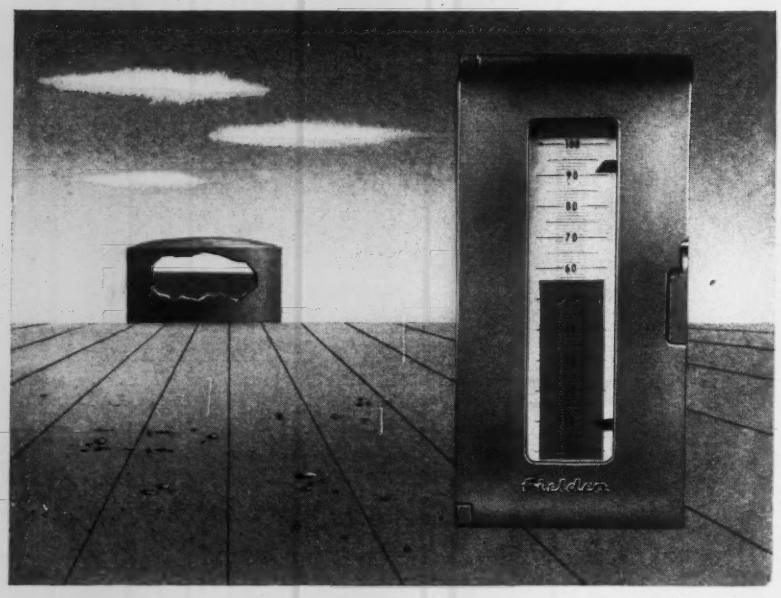
929-B Connecticut Avenue • Bridgeport 2, Connecticut

TRADE MARK

for Better Value

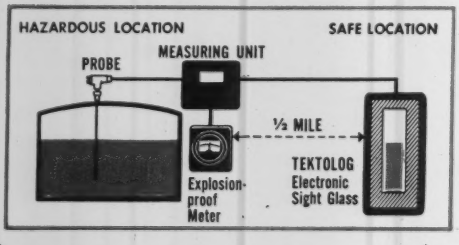
For more information circle **69** on inquiry card.

Now See Level "Inside" Vessels from Panels ½ Mile Away



With a new Fielden unit, the level of any liquid, powder, interface, or granular solid can be measured accurately in any area . . . and reproduced visually as far as ½ mile away.

This equipment now enables you to combine all the advantages of capacitance level measurement with the convenience of 8½" vertical scale indication and control. Level is measured and indicated locally and/or remotely by a Fielden Series 10 TELSTOR, Series 42 Null Balance or Series 16 Continuous Level Telemetering System. A TEKTOLOG Electronic Sight Glass of panel space-saving design then shows level graphically by means of a moving colored tape.



Features

- TEKTOLOG Electronic Sight Glass available for electric control with up to 4 separate points
- Indicates level of any material—conducting or non-conducting
- Measures entire spans or any portion—up to 150 or 200 feet.

Robertshaw-Fulton CONTROLS COMPANY

FIELDEN INSTRUMENT DIVISION
Dept. A, 2920 N. 4th St., Philadelphia 33, Pa.

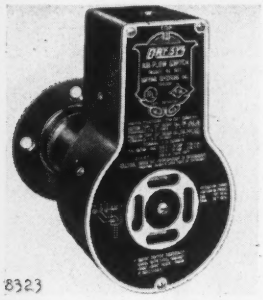
Please send me bulletins on the following systems using Fielden TEKTOLOG Electronic Sight Glass

- ☐ TELSTOR Continuous Level System
- ☐ Series 16 Continuous Level Telemetering System
- ☐ PNEUTRONIC Level Control
- ☐ TEKTOR Level Limit Control
- ☐ Series 42 Null-Balance Continuous Level System

NAME_____ TITLE_____
COMPANY_____
ADDRESS_____
CITY_____ ZONE____ STATE_____

For more information circle **70** on inquiry card.

NEW INSTRUMENTS



rent to electric heaters, operate electric damper motors, operate signalling devices and alarms.—*Drying Systems, Inc.*, 1800 *Foster Ave., Chicago* 40, *Ill.*

For more information circle **217** on inquiry card.

PITOT TUBE

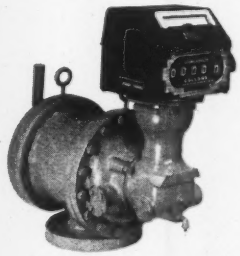
New adjustable Pitot tube to check flow of corrosive and non-corrosive pipe-line fluids, is available in stain

less steel, Monel and other metals. features safety lock permitting it to be secured in any desired position; fits male or female connections through gate or corporation valve installations. Standard lengths 1 to 5 ft. —*C-Mar Corp., Manasquan, N. J.*

For more information circle **218** on inquiry card.

LIQUID METERS

New line of crank-controlled "Rotocycle" liquid meters feature larger capacity, longer life, quiet operation and



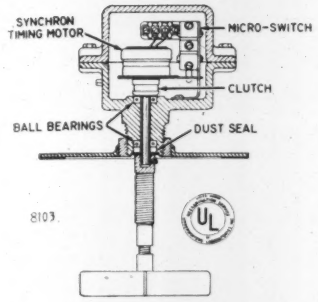
reduced maintenance costs. Three models with flow capacities from 400 to 1,000 gpm are available.—*Meter and Valve Division, Rockwell Mfg. Co.*, 400 *North Lexington Avenue, Pittsburgh* 8, *Pa.*

For more information circle **219** on inquiry card.

LEVEL

EXPLOSION-PROOF BIN LEVEL INDICATOR

New model of maker's "Roto-Bin-Dicator" bears UL label for use in hazardous atmospheres Class I, Groups C and D and Class II, Groups E, F & G (vapors of ethyl ether, gasoline, petroleum, alcohol, acetone, lacquer solvent, natural gas and at-



mospheres charged with grain dust, carbon black, coal or coke dust, and atmospheres containing metal dust). —*The Bin-Dicator Co.*, 13946-205 *Kercheval, Detroit* 15, *Mich.*

For more information circle **220** on inquiry card.

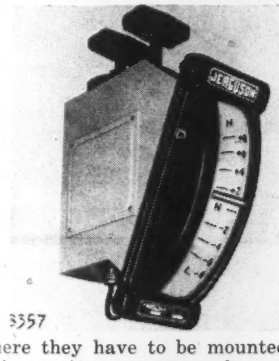
REMOTE TANK GAGE

New "Capacity Telemeter" measures level in storage tanks and bins located more than ¾ mile away; is unaffected in accuracy by changes in weather conditions or electrical properties of coaxial cable. System consists of a measuring unit, a remote probe unit for each tank, and a recorder or precision indicator.—*Fielden Instrument Div., Robertshaw-Fulton Controls Co.*, 2920 *N. 4th St., Philadelphia* 33, *Pa.*

For more information circle **221** on inquiry card.

LIQUID LEVEL GAGES

New models of "Truscale Remote Reading Liquid Level Gages" are available as inclined gages for use



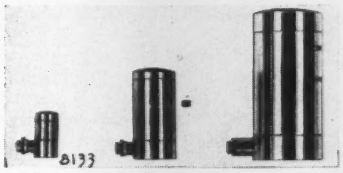
where they have to be mounted high or low on instrument panel or at other points. For low installations, cover and scale incline upward—*Jerguson Gage & Valve Co.*, 80 *Fellsway, Somerville* 45, *Mass.*

For more information circle **222** on inquiry card.

VIBRATION, MOTION

VIBRATION-MEASUREMENT ACCELERATION PICKUPS

New "Models M-142B, M-191 and M-198 Accelerometers" are stiffness-controlled vibrating systems for making transient vibration measurements over a wide frequency range of operation; reveal high-order harmonic

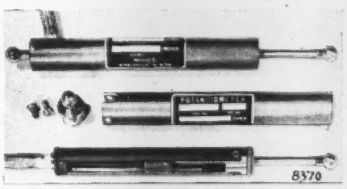


components of vibrations; facilitate making vibration measurements for noise reduction; are free from phase shift between applied acceleration and generated output voltage; are sensitive only to axial component of vibration. Sensitivity is independent of frequency over entire frequency range of operation. Total ranges of set: 0.001-2000 *G*, 10-80,000 cps.—*Massa Laboratories, Inc., Hingham, Mass.*

For more information circle **223** on inquiry card.

DISPLACEMENT PICKUP

New miniaturized linear-travel voltage-dividing resistor is designed to meet requirements of control systems



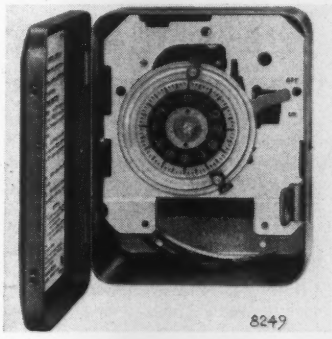
in industrial machinery, aircraft, guided missiles, etc. Available in single or dual-element units. Among features: dual precious-metal wipers; up to 60,000 ohms per inch resistance; resolution as low as 0.0008"; zero backlash.—*Minco Engineering & Mfg.*, 740 *Washington Avenue North, Minneapolis* 1, *Minn.*

For more information circle **224** on inquiry card.

TIME, SEQUENCE, etc.

TIME SWITCHES AND TIMERS

Seven new time switches added to maker's "Intermatic" line offer versatility in control of electric circuits over periods of 2 sec to 24 hr. Among them "T960 Series" for 1 to 96 on-off operations every day; seven-day "V21000 Series" for a weekly schedule with different timing periods daily if desired; "V27000" for controlling operations of 5 or 15 min. intervals during a 24-hr period. Program



FOR THE QUESTION...

What will happen?

THE ANSWER IS...

A53+MR-1*

To obtain missile break-up data, the combination of Model A53 high current output accelerometers and a Model MR-1 recorder has proven to be a successful system.

STATHAM Model A53 accelerometers produce a signal of ±0.4 milliampere into a 40 ohm load. They are small in size and light in weight.

Please request Statham Bulletin No. A53.

The Model MR-1 is a miniature airborne magnetic tape recorder manufactured by North American Instruments, Inc., 2420 N. Lake Ave., Altadena, California, and is described in their Bulletin 104.

* The formula "A53 + MR-1" demonstrates the ability of Statham Laboratories to cooperate with recorder manufacturers in a joint effort to serve the engineering field.

Statham
LABORATORIES

For more information circle **71** on inquiry card.

Designing for High Temp?

Designing for Low Temp?

You Need the Special Advantages of Engineered Lubricants from ANDEROL

The products you design can be used at any temperature without change of lubrication . . . if your designs include a specially engineered Anderol Lubricant. Call the Lehigh Lubrication Specialist while your product is still in the design stage. Regardless of volume or requirements, Lehigh will engineer a special Anderol Lubricant to do the job.

WRITE TODAY:

For complete data and government specifications. Our laboratories are at your service.

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ENGINEERED LUBRICANTS
Lehigh Chemical Company
CHESTERTOWN, MARYLAND

For more information circle **72** on inquiry card.

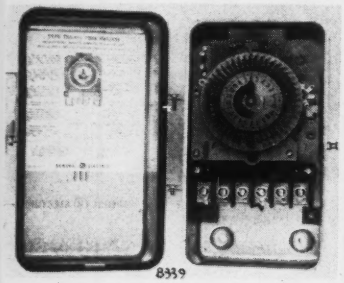
NEW INSTRUMENTS

timers are also included among new models, to control 1 to 288 daily operations; also "C8300 Series" 12-minute cycle repeater timer.—*International Register Co., 2624 W. Washington Blvd., Chicago 12, Ill.*

For more information circle **225** on inquiry card.

TIME SWITCH

New "TSA-555" general-purpose time switch, similar in design and operation to recently-announced "TSA-

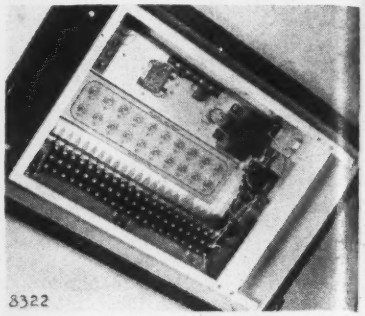


40," is distinguished by multi-tripper dial and availability of intermittent contacts; features exceptional flexibility for use wherever many varied ON-OFF schedules are required during a 24-hour period.—*General Electric Co., Schenectady 5, N. Y.*

For more information circle **226** on inquiry card.

SEQUENCE CONTROLLER

New "Cat. 200 Timed Operations Preselector" has a number of multiple contacts for multiple intervals (or



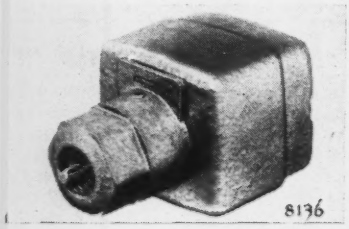
operations) independently and individually adjustable, automatically following a selected sequence or cycle, which can be selected to repeat or be reset. Its action is analogous to that of a multiple-cam timer in which each cam controls a number of on and off periods by means of a snap-action switch (number of snap-action switches equal to number of cams), such timer having a variable speed of rotation. New instrument performs such functions electrically with accuracy unobtainable with mechanical settings.—*Henry G. Dietz Co., 12-16 Astoria Blvd., Long Island City 2, N. Y.*

For more information circle **227** on inquiry card.

SPEED, REPETITION RATE, COUNT

TACHOMETRIC PICKUPS

New "Series 34" capacitor-type tachometer takeoff heads are for use with maker's indicators; measure



speeds between 100 and 5000 rpm; are available with A.N. or S.A.E. screw mounts. Output proportional to speed is transmitted to indicator up to 1000 feet away.—*Metron Instrument Co., 432 Lincoln St., Denver 9, Colo.*

For more information circle **228** on inquiry card.

MOTOR SPEED CONTROLLER

New "TRAK" magnetic amplifier motor speed control system, through multiple-feedback design, measures motor's operating speed by sensing its armature current and voltage drop, and applies an instantaneous correction voltage whenever load conditions or other effects threaten a speed change. Speed of small-motor equipment can be preset by means of

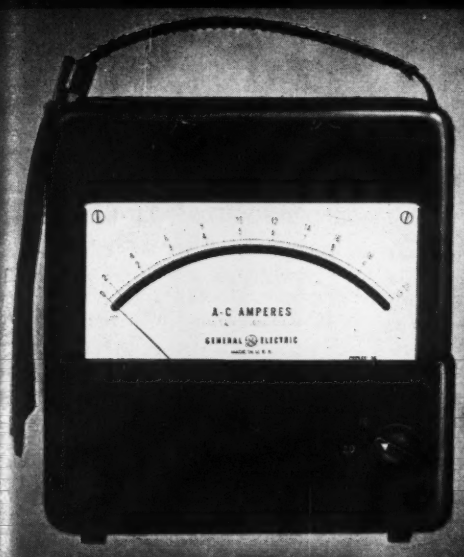
a conventional 2-watt rheostat, remotely located if desired. Unit can be attached to any 115-v universal (series) motor from 1/50 to 1/15 hp without any wiring changes.—*CGS Laboratories, Inc., 391 Ludlow St., Stamford, Conn.*

For more information circle **229** on inquiry card.

TACHOMETRIC PICKUPS

New "Model 2000AG" explosion-proof (UL-listed) tachometer pickup is a dual signal generating device which provides (1) electrical impulses for operation of electronic digital counters and (2) a 3-phase self-generated electrical output for powering a 3-phase synchronous electric tachometer indicator. Its wave-shape is sinoidal; output is about 1 v rms at 100 rpm. ★New "Model 2043" dual-pad-mount tachometer pickup, designed to "sandwich" mount be-

Instruments for Precision Measurements



AP-11 is rated at 1/2 of 1%

AP-12 is rated at 1/4 of 1%

GENERAL ELECTRIC ANNOUNCES . . .

NEW PORTABLES WITH 3 BIG ADVANTAGES

New AP-11 and AP-12 portables give you sustained high accuracy, convenience of use, and high scale readability for precise measurements in a wide variety of applications.

Newest Additions to the expanded line of General Electric portable instruments are the high-accuracy AP-12 for precise a-c/d-c measurements and the AP-11 for general a-c/d-c measurements. The new AP-12 is designed to replace the well-known General Electric type P-3 instrument.

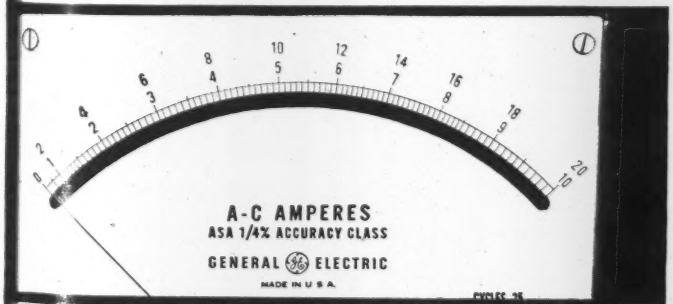
You Get Three Big Advantages for precise measurements. Sustained high accuracy comes from spring-mounted jewel bearing design which avoids pivot blunting. Convenience of use comes from universal terminals and rugged, lightweight Textolite* plastic cases. High readability comes from nearly uniform scale distribution. This is especially true at lower ends of scales.

For High-accuracy Testing, the new AP-12 for a-c/d-c and the matching DP-12 for d-c are rated at ¼ of 1% of full-scale values. Both instruments are ideal for laboratory, electric utility, factory, and field applications.

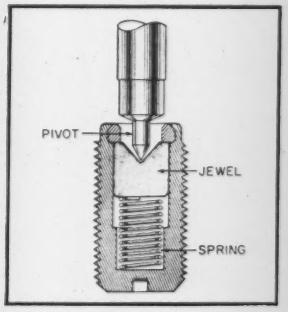
For General Testing, the AP-11 for a-c/d-c and the matching DP-11 for d-c are rated at ½ of 1% of full-scale values and provide accurate measurements in electric utility, contractor and repair shop applications. Small-size types AP-9 for a-c (rated at ¾ of 1%) and DP-9 for d-c (rated at ½ of 1%) are also available.

**Reg. trade-mark of General Electric Co.*

LOOK AT THE FEATURES IN G-E PORTABLES THAT GIVE PRECISE MEASUREMENT



MORE UNIFORM SCALE DISTRIBUTION is now possible for high-accuracy a-c measurements. Note how much more precisely readings can be made, especially at lower end of scale. New window admits light from three sides.



SPRING-MOUNTED JEWELS cushion pivots to avoid pivot blunting and jewel cracking.

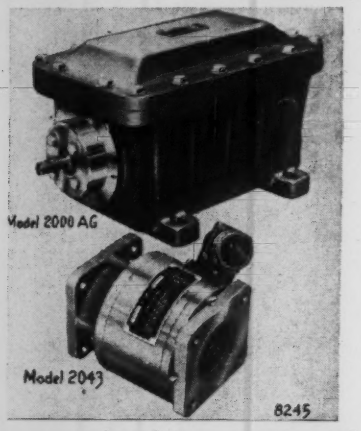
WRITE FOR BULLETINS—Ask for GEC-979, GEC-1384 and instrument catalog GEC-1016.

FOR FULL INFORMATION, WRITE SECTION 582-18, GENERAL ELECTRIC CO., SCHENECTADY 5, N. Y., OR CONTACT YOUR NEAREST G-E APPARATUS SALES OFFICE.

GENERAL ELECTRIC

For more information circle **73** on inquiry card.

NEW INSTRUMENTS

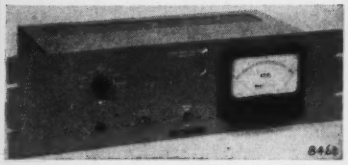


tween an aircraft tac generator and engine's AND-20005 mounting pad, provides necessary high-frequency signal required for operation of electronic tachometers and frequency counters during engine test and experimental work. ★New "Model 2060" (not illustrated) explosion-proof (UL-listed) functionally similar to "2043."—*I-L-S Instrument Corp.*, 10701 *Briggs Rd., Cleveland* 11, *Ohio.*

For more information circle **230** on inquiry card.

PULSE RATEMETERS

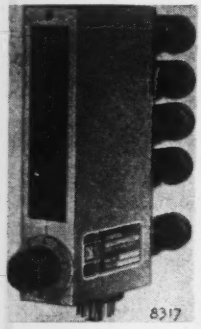
New "FR Series Pulse Rate Converters" for use with turbine flowmeters provide signal proportional to



frequency of input; are available for up to ten input channels, in relay rack or cabinet enclosures. Voltage output can operate indicators, recorders, or controllers. Input frequency range 5 to 3000 cps. Five internal calibration checking frequencies are provided.—*Waugh Engineering Co.*, 7842 *Burnet Ave., Van Nuys, Calif.*

For more information circle **231** on inquiry card.

PRESET DECADE COUNTER



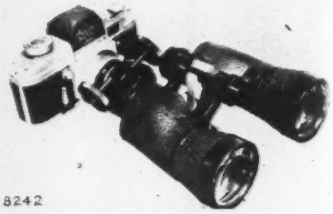
New "Model 101A Preset Decade Counting Unit" provides an output pulse at a selected number at rates in excess of 40,000 counts per second (100,000 if reset is not required). It is of coincident type with an 11-pin base, pulse output and 0 reset. Companion "Model 101B" offers a 9 reset; "Model 101C" is also coincident type with 11 pin base plus 4 pin plug, 4 line 1—2—2—4 coded output, 0 reset for operation of digital printers, etc. —*Computer-Measurements Corp.*, 5528 *Vineland Ave., N. Hollywood, Calif.*

For more information circle **232** on inquiry card.

PHOTOGRAPHY

BINOCULAR-TO-CAMERA ADAPTER

New "Alpakern" adapter for Alpa 35mm single-lens reflex camera, attaches high-resolution Kern binoculars from 6 x 24 through 12 x 50 to front of Alpa's 50mm F/1.8 Kern Switar apochromat.—*Karl Heitz, Inc.*, 480 *Lexington Ave., New York* 17, *N. Y.*



For more information circle **233** on inquiry card.

35-MM CAMERA

New "Diax 1B" 35mm camera is said to "bring many quality features

Sapphire Wear Part shown here is from a Hook-forming Gear at the Westinghouse Lamp Division, Bloomfield, N. J.

Sapphire Insert Cuts Costs 85%

for Westinghouse Lamp Division—and they write us:

"The use of the sapphire at the critical wear point has drastically reduced the wear problem, for the Forming Gears with inserts outlast the gears without inserts at an average ratio of 10:1. Using a sapphire insert in the gear has meant an 85% reduction in the yearly cost of this item in addition to reducing expensive machine downtime."

If you have a friction or wear problem that means frequent replacement of close-tolerance, expensive parts such as this, send for an analysis by our engineering staff no charge, of course. Other typical solutions are illustrated in our brochure . . . send for it today!

aurele m. gatti inc. "Precision Sapphire Products Miniature Sub-Assemblies"

Main Office and Factories — 526 Tindall Ave., Trenton, N. J.
Manufacturing Subsidiary — Guayama, Puerto Rico

For more information circle **74** on inquiry card.

For after shutdown protection...

AGASTAT®

TIME DELAY RELAY

Allows operation of auxiliary protective devices* after operating cycle is stopped. Easily installed in any electrical line.

The AGASTAT is—

- light, versatile, dependable.
- instantaneous recycling.
- unaffected by voltage variations.
- adjustable in timing from 0.1 second to more than 10 minutes.
- available in models that offer delays on energizing and de-energizing, two step delays, manually-actuated time delay switch, remote push button control.

***WRITE** for new 4-page application folder describing how one large company solved its after-operating problem. Address Dept. A21-129

AGA DIVISION

Elastic Stop Nut Corporation of America

1027 Newark Avenue, Elizabeth, New Jersey
Pioneers in pneumatic timing.

For more information circle **75** on inquiry card.

ENGINEERS · SCIENTISTS

RECENT BREAKTHROUGHS IN SUPERSONIC AND HYPERSONIC KNOWLEDGE AND TECHNOLOGY— BASIS OF MAJOR RESEARCH AND DEVELOPMENT ACCELERATION AT REPUBLIC AVIATION

Alexander Kartveli, Vice President in Charge of Research and Development, Invites the Inquiries of High Calibre Engineers and Scientists

Recent discoveries justify a large scale, long range integrated attack on all the complex, interrelated aspects of passage through the upper atmosphere, in the opinion of Alexander Kartveli, creator of Republic's famous family of Thunder-Craft.*

Republic's R & D activities are now being materially augmented and accelerated to speed the exploration of this new knowledge and technology. The broad areas under study are:

- **Hypersonic and Satellite Weapons Systems.**
- **Advanced Propulsion Systems.**
- **Nuclear Energy Applications to Aircraft.**
- **Capabilities of Materials in Hypersonic and Nuclear Environments.**
- **Electronic systems development to exploit the full potential of the most radical concepts of flight.**

The quality of the opportunities for creatively unhampered professional men with specialized experience in many fields is evident. Republic welcomes your inquiries regarding positions in any one of the areas outlined:

Positions Open At All Levels

NUCLEONICS
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FLIGHT CONTROL SYSTEMS
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MATERIALS

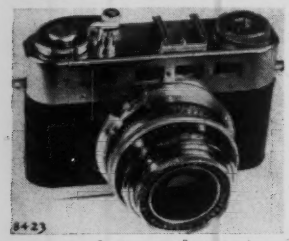
*Each Thunder-Craft in turn has represented a significant advance in aircraft design. Latest member of this famous family is the incredible F-105 Thunderchief, most advanced USAF fighter-bomber — supersonic and nuclear-weapons carrying.

Please address complete resume of your technical background to: Engineering Personnel Manager Mr. David G. Reid

REPUBLIC AVIATION

FARMINGDALE, LONG ISLAND, NEW YORK

NEW INSTRUMENTS



to amateur photographers at a fraction of higher priced imports."—*Karl Heitz, Inc.*, 480 *Lexington Ave., New York* 17, *N. Y.*

For more information circle **234** on inquiry card.

FOR AIRCRAFT AND GUIDED MISSILES

AERIAL RECONNAISSANCE ...CAMERA

New "KA-20" lightweight (20-lb) aerial reconnaissance camera, for use in missile and high speed drone aircraft, can also be used for more conventional aerial reconnaissance tasks; uses 9x9" film and a 6" metrogen lens to provide a maximum area of coverage. Built-in "Image Motion Compensation" compensates for airplane's forward speed.—*Hycon Mfg. Co.*, 2961 *E. Colorado, Pasadena, Calif.*

For more information circle **235** on inquiry card.

MISSILE CHECKOUT SYSTEM

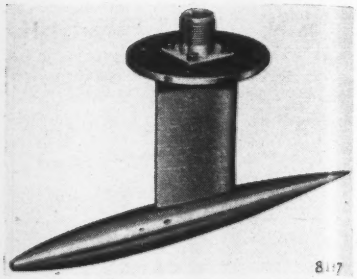
New automatic system for providing absolute direct and alternating voltage and frequency values, and

go/no-go checks with both printed and visual readout, can be easily expanded to include similar measurements on ac and dc ratios and resistances by using maker's standard modular units; is programmed by a punch tape memory.—*Electro Instruments, Inc.*, 3794 *Rosecrans St., San Diego* 10, *Calif.*

For more information circle **236** on inquiry card.

AIR TEMPERATURE PROBE

New "Model 49127 Adiabatic Temperature Probe" for extremely accurate measurement of airstream stagnation temperatures in aircraft and missile applications is available with choice of two fast-response temperature elements to provide either a voltage or a resistance output proportional to airstream stagnation tem-



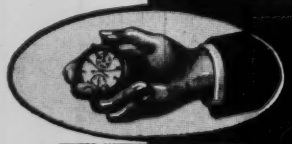
perature. Recovery factor 0.985; response time 0.25 sec or less; repeatability within 0.5%.—*G. M. Giannini & Co., Inc.*, 918 *East Green St., Pasadena* 1, *Calif.*

For more information circle **237** on inquiry card.

FREQUENCY-TO-VOLTAGE CONVERTER

New "Model FR-301 Transistorized Converter" converts variable-frequency input signals (from turbine flowmeters or ac tachometer generators) into a 0-5-v signal suitable for telemetering; is intended for guided missiles and piloted aircraft; employs seven transistors; has span adjustment to give 5-v output for a wide range of

RACINE



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GUINAND TIMERS

GALLET CHRONOGRAPHS

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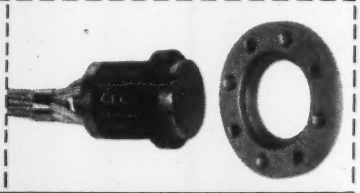
For more information circle **76** on inquiry card.

accurate pressure measurement at 600° F



CEC 4-316 PRESSURE PICKUP

Newest of CEC's "4-300" pressure pickups, the 4-316 provides accurate, dependable operation at the elevated temperatures of jet and rocket research and supersonic flight testing. It employs the unbonded-strain-gage principal with special internal construction that ensures hundreds of hours of accurate service at ambient temperatures as high as 600°F— the highest operating range of any standard pressure pickup on the market today.

PRESSURE RANGES ... gage and differential from 15 to 150 psi

COMPENSATED TEMPERATURE RANGE ... +75°F to 600°F (operable from −100°F to 650°F without damage)

SENSITIVITY ... 20 mv f.s. (± 10 mv f.s. for differential units)

EXCITATION ... 5 v d-c or a-c rms @ 0-20 kc

LINEARITY AND HYSTERESIS ... less than 1% f.s.

INPUT/OUTPUT IMPEDANCE ... 350 ohms

CABLING ... 30" insulated, coded, 4-conductor, permanent cable.

SIZE ... ½" dia., ¾" length, nominal

Complete calibration certificate with every unit. Send for Pickup Bulletin CEC 1568–X14.

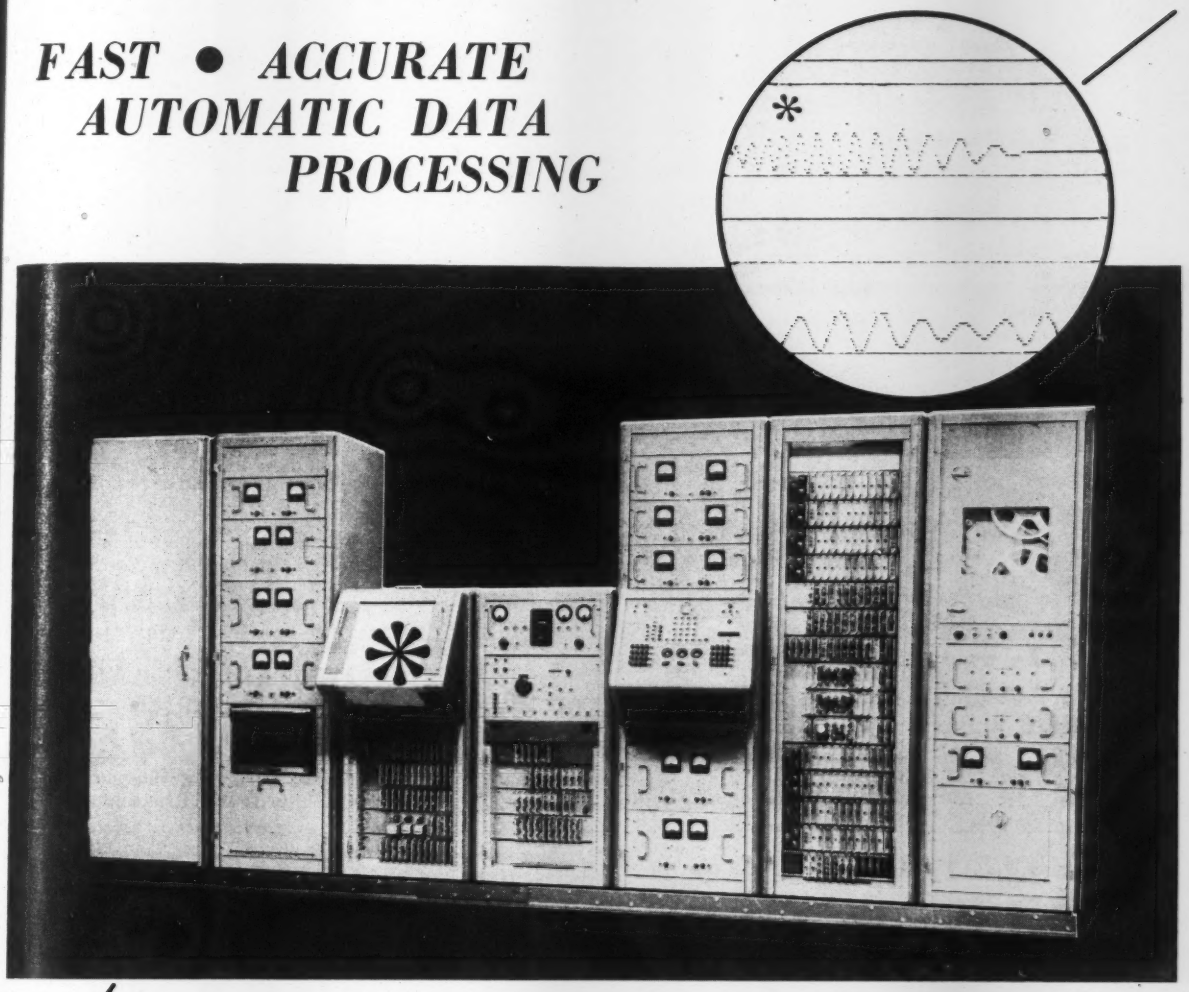
Consolidated Electrodynamics

300 North Sierra Madre Villa, Pasadena, California

NATIONWIDE COMPANY-OWNED SALES AND SERVICE OFFICES

For more information circle **77** on inquiry card.

FAST • ACCURATE AUTOMATIC DATA PROCESSING



FEATURING INSTANTANEOUS QUICK-LOOK RECORDING

THE RADIATION, INC. DATA PROCESSING SYSTEM bridges the gap between data collection and data reduction. It accepts analog or digital inputs and converts the data to a form acceptable by high-speed digital computers. Information is handled in digital form throughout, maintaining extremely high accuracy. A quick-Look analog plot of all information being processed is simultaneously available.

This plot, in real time, is especially valuable for editing out unnecessary information and reducing computer load. The system features automatic programming and eliminates normal manual procedures necessary to prepare the collected data for computer input. Thus, much valuable time is saved between test and evaluation — allowing results of previous tests to be incorporated in changes in design and procedure with little delay.

This equipment can be fitted to your particular data handling problem. Write for complete information to Dept. G

Personnel Inquiries, Invited

RADIATION Inc. Melbourne, Fla. Orlando, Fla.

Electronics • Avionics • Instrumentation

For more information circle **78** on inquiry card.

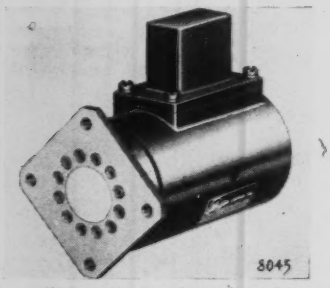
NEW INSTRUMENTS

input frequencies.—*Waugh Engineering Co., 7842 Burnet Ave., Van Nuys, Calif.*

For more information circle **238** on inquiry card.

ROTATION TYPE ISOLATOR

New "Model W 152-2A" Faraday rotation type ferrite isolator for airborne microwave applications weighs

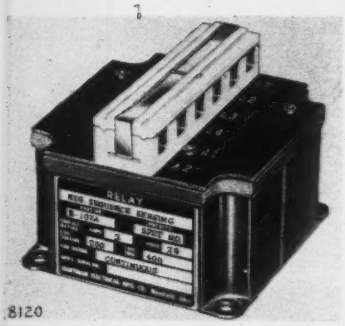


6 oz; will handle 100 kw of peak power and give 25 db of isolation with an insertion loss of less than 0.25 over a 200-300 Mc bandwidth in 8-12 kMc band.—*Kearfott Company, Inc., 253 No. Vinedo Ave., Pasadena, Calif.*

For more information circle **239** on inquiry card.

NEGATIVE-SEQUENCE-SENSING RELAY

New "Unbalance Detector" employs all static components for high reliability to protect 115/200-v 3-phase



400-cps power systems; is sensitive to phase unbalances of as little as 5 negative sequence volts.—*Hartman Electrical Mfg. Co., Mansfield, Ohio.*

For more information circle **240** on inquiry card.

SUBMINIATURE BLOWER

New "Model BC 910 B-1," featuring a 1"-dia. motor, is designed especially for cooling airborne electronic equip-

ment; operates on 115 v, 400 cps; at 20,000 rpm it delivers 8 cfm at 1" back pressure.—*Induction Motors Corp., 570 Main St., Westbury, L. I., N. Y.*

For more information circle **241** on inquiry card.

COMPUTING and DATA PROCESSING

CARD CONVERTER

New "ALWAC Card Converter" translates alphabetically and decimally coded data recorded on cards into

binary language understood by "ALWAC" electronic digital computer. Computer-processed data can then be recorded on cards or tape for storage.—*Logistics Research Inc., 141 South Pacific Ave., Redondo Beach, Calif.*

For more information circle **242** on inquiry card.

AUTOMATIC TABULATING TYPEWRITER

New "Electric Typewriter with Electronic Tabulation" speeds preparation of business forms containing blank fill-in areas. Electronic "read-

PROTECT PRESSURE-SENSITIVE INSTRUMENTS . . . POSITIVELY

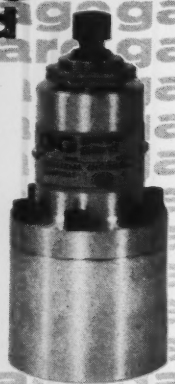
GG gage gard

Seals off gage or manometer connection at any pre-set pressure. Will repeat within 1% of scale. Will release 2% below cut-off point.

Models available with cutoffs from 20" water to 9000 psig. liquids and gases. Designed to withstand and hold closed against 10,000 psig.

Marine models available.

Write for Bulletin 541-G for full details and prices.



INDUSTRIAL ENGINEERING CORPORATION
525 E. Woodbine, Louisville, Ky.

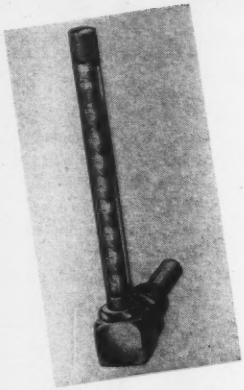
For more information circle **79** on inquiry card.

Standardize on Easy-to-Read

YEL ⊖ BAK
Reg. U. S. Pat. Office

FLAT BORE ENGRAVED STEM

MIDGET INDUSTRIAL THERMOMETERS



★ ACCURATE—to within a fraction of a degree

★ EASY - TO - READ—broad — flat stripe — mercury column in a yellow stem

★ ECONOMICAL—replacement can be inserted on-the-job without difficulty

★ ARMOUR PROTECTED—to resist corrosion and dirt

★ TWO TYPES—angle and straight stem

ASICO
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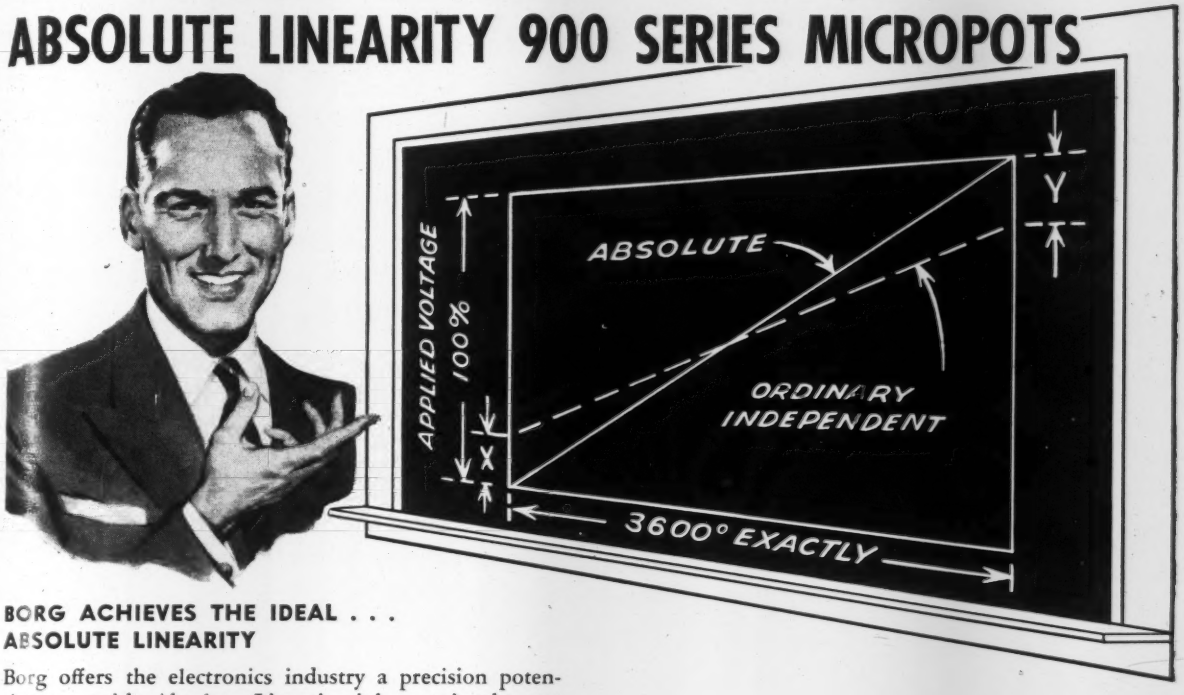
2903 N. 12th STREET
PHILADELPHIA 33, PA.

For more information circle **80** on inquiry card.

NO TRIMMING NECESSARY WITH BORG ABSOLUTE LINEARITY 900 SERIES MICROPOTS



BORG ACHIEVES THE IDEAL . . . ABSOLUTE LINEARITY

Borg offers the electronics industry a precision potentiometer with Absolute Linearity inherent in the pot itself. It requires no trimming of any kind!

THE END OF UNCERTAINTY

Embodied in Borg's new 900 Series 10-turn and 3-turn Precision Potentiometers are exclusive advantages that provide this high degree of accuracy. You get from zero to 100% of applied voltage over exactly 3600° (or 1080°) of shaft rotation.

This means no such parameters as electrical rotation tolerances, end resistance or jump-off resistance need be considered error in output. Many doors, formerly closed to electronic design engineers, are now opened by Borg Absolute Linearity.

ORDINARY INDEPENDENT LINEARITY

Note the line marked "Ordinary Independent" on the blackboard diagram. This line is unable to go to zero and 100% of applied voltage because of X and Y known as end resistances. Therefore, trimming is required to compensate for the potentiometer errors of end resistances X and Y.

Now, note that the line marked "Absolute" goes through zero applied voltage output at zero shaft rotation and through 100% applied voltage output at 3600° of shaft rotation. This is the reference line for absolute linearity and is inherent in the Borg 900 Series potentiometer. Thus Borg achieves absolute linearity without trimming of any kind.

SIMPLICITY ASSURES RELIABILITY AND ACCURACY

Simplicity of the Borg 900 Series Micropot affords greater accuracy and reliability. It eliminates such possible sources of error as trimming errors, unstable trimming, resistances, etc. Another Borg advantage simplifies assembly and reduces possibility of error. The Borg CCW mechanical stop is set up to provide a phasing point. This exclusive advantage reduces field replacement to the purely mechanical process of attaching leads and phasing from the present stop.

ABSOLUTE LINEARITY REDUCES COST

The accuracy and reliability of your equipment is improved with a Borg 900 Series potentiometer which also effects a savings in time and money. Your cost is lowered by eliminating trimming resistors and the technically trained labor competent to install them.

Many other advantages of the Borg 900 Series can help solve your potentiometer problems as they are now doing in all types of equipment from jet engines to steel mills.

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BORG EQUIPMENT DIVISION
THE GEORGE W. BORG CORPORATION
JANESVILLE, WISCONSIN

ELECTRONIC – MECHANICAL BORG EQUIPMENT

Built by Borg

For more information circle **81** on inquiry card.

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- Basic Applications of Analog Computers
- Process Control and the Analog Computer
- The G-15 Digital Computer
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by Stephen A. June, J. D. Bardis, L. H. Lurio, L. S. Polaner, O. Sagedahl, H. A. Sklenar and B. K. Yenken.

Here is a fresh viewpoint on what tomorrow's "manless factories" CAN be—a book entirely free from the boresome generalities, platitudes, exaggerations and misconceptions that have been repeated by the majority of writers on this subject.

The viewpoint is fresh because the authors sought the TRUTH in the course of their project under General George F. Doriot at the Harvard School of Business Administration.

Here, then, is THE book for all those who want FACTS rather than wild opinions.

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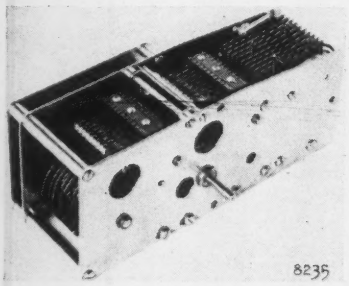
NEW INSTRUMENTS

ing" feature eliminates time-consuming tabulating adjustments when using a variety of forms. Vertical lines printed on each form with electrically-conductive ink automatically program carriage to stop at correct typing point.—*International Business Machines Corp., 590 Madison Ave., New York 22, N. Y.*

For more information circle **243** on inquiry card.

AN-DIG CONVERTER

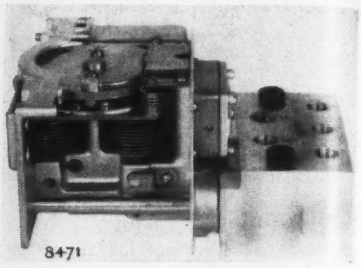
New "Model C-2-B" of maker's "Digi-Coder" shaft-position analog-to-digital converter is of advanced design incorporating, at a lower cost, many new features, such as reduced inertia, wide range of ac and dc operating voltages.—*Fischer & Porter Co., Hatboro, Pa.*



For more information circle **244** on inquiry card.

COMPUTING RELAY

New "Model 56-1 Universal Pneumatic Computing Relay" can perform any of six different arithmetic functions; receives measurements as pneumatic signals (3-15 psi) and transmits to a recorder or controller as 3-15 psi signals. Measurement signals can be received and computed according to equation desired, and various measurements can be weighted according to their values in desired equation. Process applications include flow ratioing, boiler swell compensation, flow totalizing on multiple lines, etc.—*The Foxboro Co., Foxboro, Mass.*



For more information circle **245** on inquiry card.

CHARACTER-DISPLAY TUBE

New "Type C7C11" is an entirely new model of the "Charactron Shaped-Beam Tube," which can reproduce 1,200,000 tiny letters and numbers per minute for recording photographically. It is much smaller than other "Charactron" models designed and built for direct viewing. Small size of characters (0.035" high) enables 7" tube to reproduce nine times the information density (characters per square inch) possible with other "Charactron" models; whence much greater efficiency for use with photo-recording devices in an electronic computer readout system.—*Stromberg-Carlson Div., General Dynamics Corp., Rochester 3, N. Y.*

For more information circle **246** on inquiry card.

ELECTRONIC COMPUTER-PROCESSOR

New "Elecom 125," said to be "the first medium-sized computer system to separate data-handling and computing into two different operations," comprises "Elecom File Processor" and "Elecom Electronic Computer." File processor sorts, collates, separates and categorizes data, relieving the computer of these routines. Computer performs arithmetic calculations, updating and summary compilations. Processor and computer can operate together or independently, simultaneously or one at a time.—*Underwood Corp., Electronic Computer Div., 35-10 36th Ave., Long Island City 6, N. Y.*

For more information circle **247** on inquiry card.

What are you doing?

Remember the tale of the three stone-cutters?

One day, an old scholar stopped to watch three stone-cutters at their work.

All three were cutting stone into blocks for a new cathedral. The old man went up to each of them in turn and asked the same question.

He asked, "What are you doing?"

The first one replied, "I'm cutting stone, of course. That's plain to see."

The second stone-cutter answered, "What am I doing? I'm earning five florins a day."

But the third man, though he, like the other two, was cutting stone, made this reply:

"I'm building a cathedral," he said.

Like this stone cutter, the engineers and scientists at Remington Rand Univac® have their eyes on the final objective of their work.

Remington Rand believes that a man can look beyond his appointed task without overlooking it. The result is an atmosphere where men are stimulated to seek new ideas and where they feel free to express them. This means that a continual flow of imaginative, creative thinking goes into Univac — one of the big reasons for Univac's leadership in the field of computing systems. It also means that the men who make Univac win early recognition of ability and the rewards that go with it.

If you prefer "building cathedrals" to "just cutting stone", investigate these openings.

IMMEDIATE OPENINGS FOR:

ELECTRONIC DESIGN ENGINEERS . . . Must have degree with experience in pulse circuitry, digital computers or data processing equipment.

ELECTRO-MECHANICAL DESIGN ENGINEERS . . . Must have bachelors degree in engineering. However, extensive mechanical design background may substitute for some college.

MECHANICAL ENGINEERS . . . Must be graduates of B.S. or M.S. levels. Will work on development of automation instruments.

LOGICAL DESIGNERS . . . Experience in logical design for digital computers.

FIELD LOCATION ENGINEERS . . . Must have college degree in scientific or engineering fields and experience in electronics.

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More Accurate Level Reading of LOW TEMPERATURE LIQUIDS . . .

JERGUSON

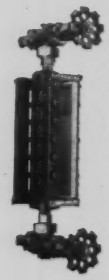
Large Chamber

NON-FROSTING* GAGES

YOU get the highest possible accuracy of reading on low temperature, low boiling point liquids with the patented Jerguson Non-Frosting Gage in the New Large Chamber model . . . because it insures less turbulence at the meniscus, and clear vision at the vision slot.

This new Jerguson model has 6 times larger area at the meniscus than the standard gage, so that there is a marked reduction in turbulence with light gaseous fluids that tend to boil or surge. Moreover, the problem of frosting encountered with these liquids has been eliminated by a patented frost preventing unit extending from the gage glass. This special transparent unit projects beyond the cover bolts and prevents frost from building up over the vision slot.

Here's a dual feature gage that assures greatly increased accuracy of reading for the process industries. If you have a problem with light gaseous fluids, or with gage frosting, it will pay you to investigate the new Jerguson Large Chamber Non-Frosting Gage . . . reflex or transparent.



Jerguson Large Chamber Gage, Transparent Type, with the patented Non-Frosting Gage Glass Extension. Write for literature on this gage, and on other non-frosting Jerguson models.

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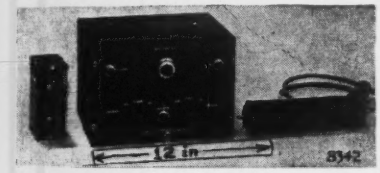
For more information circle **84** on inquiry card.

NEW INSTRUMENTS

ACTUATORS

POWER POSITIONERS

New remote positioning systems for industrial applications are said to feature torque capacity independent of

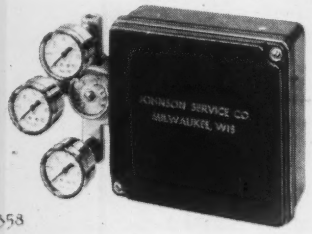


error signal magnitude, high-speed operation without overshoot or oscillation, small size actuator with exceptionally high torque capacity, excellent positioning accuracy with low dead band. Torque capacities up to 100 pound-inches; output speed corresponds to speed of input control up to limit of specific actuator used.—*Globe Industries, Inc.*, 1784 *Stanley Ave., Dayton* 4, *Ohio.*

For more information circle **248** on inquiry card.

PILOT POSITIONER

New "Precision Pilot Positioner" is designed especially for applications requiring precise repositioning even for small changes in air pressure from control instrument. Maximum power is available at all times for reposi-



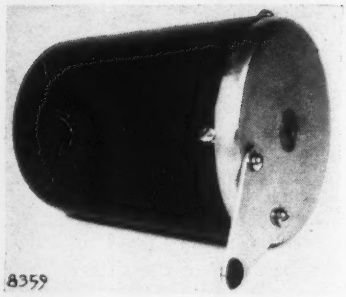
8358

tioning controlled device. Air consumption is said to be "only a fraction of that consumed by standard pilot positioners." Fast action is obtained through use of maker's proportional-action direct-acting relay; it is said that a valve "can be repositioned six times faster than with an ordinary pilot." Other features include adjustable starting points and operating ranges, a by-pass switch and indicating gages.—*Johnson Service Co., Milwaukee* 1, *Wis.*

For more information circle **249** on inquiry card.

SHAFT-MOUNTED GEARMOTOR

New "Shaftrol" provides remote and automatic control for variable speed drives, valves, pumps, feeders, etc.; mounts easily on shafts from ¼" to ⅞"; is light (aluminum housing and cover); is furnished with a torque arm or torque plate with resilient mounting that absorbs any runout that may be present in shaft to be controlled. When used on rising stem valves, its torque plate is equipped



8359

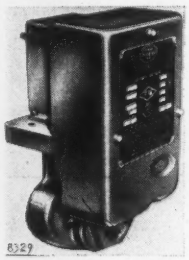
with linear bushings to allow axial movement. Wide choice of output speeds and torques. Single-phase units use an instantly reversible permanent split capacitor motor having high starting torque with low inrush current. Three phase units in larger sizes. Explosion-proof and other enclosures available.—*The Jordan Co., Inc.*, 3235 *W. Hampton Ave., Milwaukee* 9, *Wis.*

For more information circle **250** on inquiry card.

VALVES

AUTOMATIC GAS VALVES

New "Fireye Series 81L" automatic gas valves, for use with "Fireye" flame safeguard systems, have a powerful compression-type spring that automatically shuts off fuel in 0.8 second. A heavy-duty electric drive unit controls rate of opening to reach 75% of maximum fuel flow in 6 seconds. Sizes 1" to 6".—*Electronics Corp. of America, Dept. CN-12, 77 Broadway, Cambridge* 42, *Mass.*



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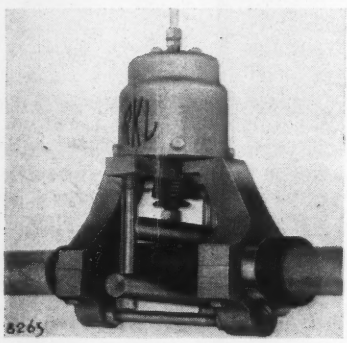
For more information circle **251** on inquiry card.

PINCH-TYPE VALVES

New ruggedized "Series R" pinch-type valves have solid connection-to-connection support. Main frame members are 40E aluminum alloy castings; oversized stem and guide rods are 303 stainless steel. Good linearity and positioning accuracy are provided by a



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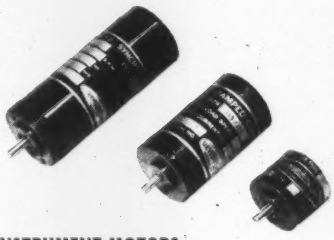
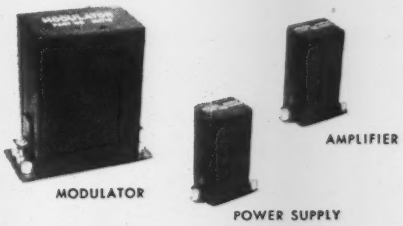
in both development and production by using SERVOMECHANISMS' proven components.



INSTRUMENT MOTORS

400 CYCLE COMPONENTS

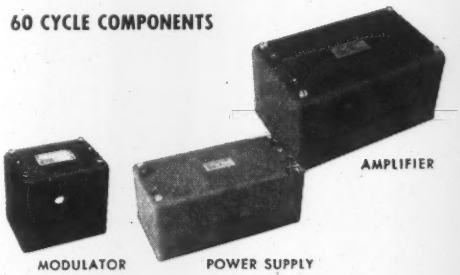


MODULATOR

POWER SUPPLY

AMPLIFIER

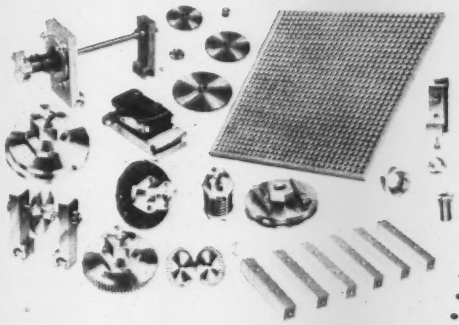
60 CYCLE COMPONENTS



MODULATOR

POWER SUPPLY

AMPLIFIER



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These proven components *are available now.* We've designed them—allowing you to concentrate your time on the application. The 60 and 400 cycle components, together with the companion instrument motors and the extensive line of Mechanical Development Apparatus, offer the Design Engineer an assortment of ready-made units that are ideally suited for closed loop control applications.

These packaged function components are plug-in units permitting quick and easy replacement *anywhere.*

Servomechanisms, Inc. manufactures these units for use in its own analog computers and control systems. *Now,* they are available as individual units. All of the components meet applicable military specifications for both prototype and production deliveries.

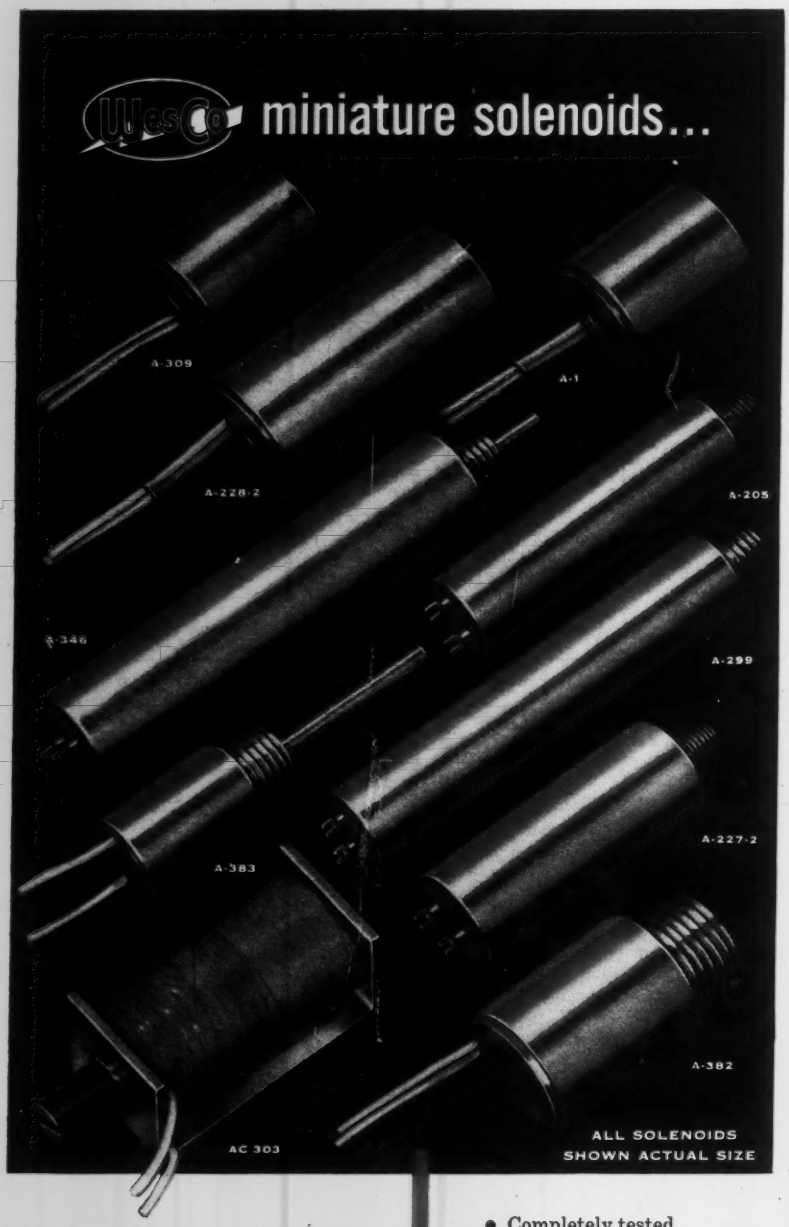
The design philosophy of packaged functions; the years of manufacturing experience, and the constant improvement of the basic units, all add up to optimum adaptability, performance and reliability.

Find out more about these quality units and how they can Save You Design Time. Write today for complete technical information.

SERVOmechaNISMS INC. EA-356

MECHATROL DIVISION, 625 Main Street, Westbury, L. I., New York

For more information circle **85** on inquiry card.



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- Mounting furnished to meet your requirements.
- HUNDREDS OF OTHER DESIGNS for both AC and DC application.
- Push or pull units to 200 lbs. force.
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For more information circle **86** on inquiry card.

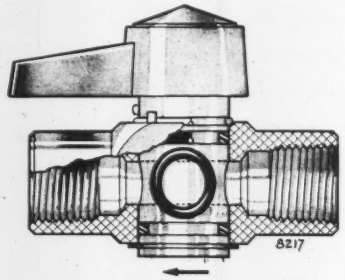
NEW INSTRUMENTS

long-stroke rolling-diaphragm motor. Sizes up to 14" with various body materials. Standard body material is pure gum rubber.—*RKL Valve & Mfg. Co., Route 38 & Rudderow Ave., Maple Shade, N. J.*

For more information circle **252** on inquiry card.

PLUG VALVE

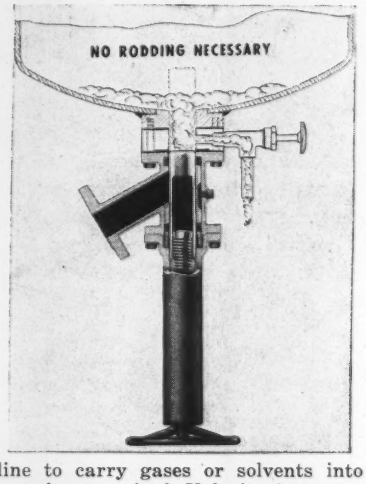
New ¼" brass plug valve provides leakproof shut-off, is operated by a handle that opens and closes effortlessly against pressure. New plug design features use of three O rings: in closed position, one O ring (on surface of plug, 90° from flow passage through plug) surrounds inlet port and provides dead-tight shut-off. In open position, valve allows a straight-through flow. Brass, ¼" pipe size.—*Circle Seal Products Co., Inc., 2181 East Foothill Blvd., Pasadena 8, California.*



For more information circle **253** on inquiry card.

RAM TYPE DRAIN VALVE

New Ram Type Drain Valve can be installed with a flange between it and vessel. Flange is tapped with a ⅜" line to carry gases or solvents into vessel as required. Valve's piston can be retracted so it stops just below flange, allowing gases or solvents to enter vessel but not to escape through valve's discharge side. Piston can be forced up into vessel to break sludge. —*Strahman Valves, Inc., 16 Hudson St., New York 13, N. Y.*



For more information circle **254** on inquiry card.

NEEDLE VALVE

New "Series A" ⅜" and ½" leak-proof metering valve with $\frac{1}{16}$" orifice requires a torque of only 24 pound-

inches to operate at 6000 psi. Over-torquing cannot damage seat or needle. Valve can be completely overhauled without disturbing plumbing or mounting.—*Robbins Aviation*, 1735 *West Florence Ave., Los Angeles* 47, *Calif.*

For more information circle **255** on inquiry card.

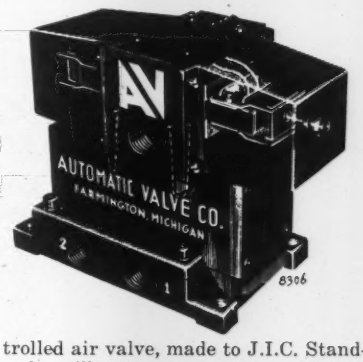
PRESSURE REGULATOR AND SHUT-OFF VALVE

New pneumatic pressure regulator and shutoff valve, operating with a closing time of 0.1 sec, is designed for rocket, ram jet and turbine engine test installations, etc., where source gas is stored under high pressure. It reduces high-pressure gas to a predetermined lower outlet pressure and acts as a zero-leakage shut-off valve. In addition, outlet pressure can be programmed with a timing device.—*AiResearch Mfg. Co.*, 9851 *Sepulveda Blvd., Los Angeles* 45, *Calif.*

For more information circle **256** on inquiry card.

DOUBLE SOLENOID AIR VALVE

New "Model 12441-500" 4-way, 4-port and 4-way, 5-port (2-pressure) pilot-operated double-solenoid-con-



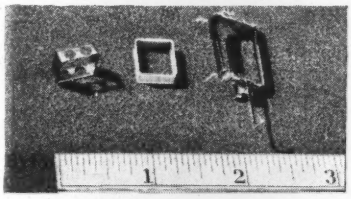
trolled air valve, made to J.I.C. Standards, will not reverse in case of electrical failure; makes possible simpler electrical circuits.—*Automatic Valve Co.*, 37415 *Grand River Ave., Farmington, Mich.*

For more information circle **257** on inquiry card.

SHOP EQUIPMENT and SUPPLIES

MOVING-COIL FORMS

New forms for electrical-instrument moving coils are made by unique specialized techniques to extremely close



dimensional tolerances, from various metals and alloys including extra-high-purity aluminum.—*H & H Machine Co., Noble & Jackson Sts., Norristown, Pa.*

For more information circle **258** on inquiry card.

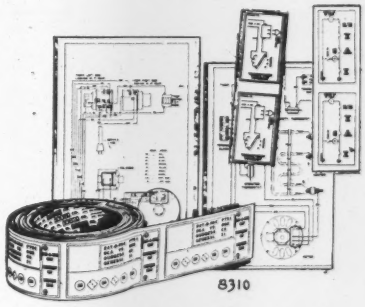
ULTRATHIN METAL STRIP

New ultra-thin metal strip is held to exceptionally close thickness tolerances. Maker can furnish it in widths up to 4" and in thicknesses from 0.010" down to 0.00012" with thickness guaranteed uniform to a tolerance of 0.00005" and a high degree of uniformity in thickness (freedom from camber) across width of strip. Wide range of materials from hard high-temperature resistant alloys to soft light metals.—*Allied Products Div., Hamilton Watch Co., Lancaster, Penna.*

For more information circle **259** on inquiry card.

SELF-STICKING DIAGRAMS

New self-sticking wiring diagrams, instruction sheets, repair parts lists, etc., come mounted on handy zip-off



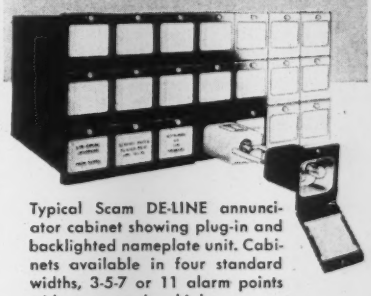
liners or fast-to-dispense rolls; can be applied directly to product; do not curl or fall off.—*W. H. Brady Co.*, 727 *W. Glendale Ave., Milwaukee* 9, *Wis.*

For more information circle **260** on inquiry card.

COPPER DISPERSION FOR PLATING NON-CONDUCTORS

New "No. 235 Dag" is a colloidal dispersion of metallic copper in a lacquer solution that provides a highly conductive surface coating. Among uses: printed circuitry, electroplating of non-conductors, application on components for radar equipment, hearing

Choose A Standard SCAM ALARM for All Your MONITORING



Typical Scam DE-LINE annunciator cabinet showing plug-in and backlighted nameplate unit. Cabinets available in four standard widths, 3-5-7 or 11 alarm points wide, any number high.

Even the most advanced automatic system needs the reliable monitoring that only good annunciators offer. And of those available only Scam gives you the benefit of broad standardization and interchangeability to cover the most specialized requirements. For instance, the DE-LINE annunciator can provide, in one standard cabinet...

1. **Backlighted nameplates or bullseye indication.**
2. **Sequential alarm identification.**
3. **Easy adaption for use with Scam DU-ALL annunciators for HI-LO indication.**
4. **Optional ringback or manual reset functions by the operation of a slide switch.**

There are many other standard features of DE-LINE annunciators that are usually provided only on special order – features that make them the most versatile available, capable of "growing" with any control system. Write for literature or call any representative in the cities listed below.

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For more information circle **88** on inquiry card.

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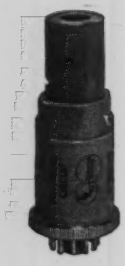

EECO PLUG-INS

Every day more organizations are discovering the advantages of using EECO plug-in circuits in developing electronic equipment. Why not join this winners' circle and prove the advantages for yourself?

❀ Your engineers will be free to concentrate on the design of systems instead of routine circuit detail.

❀ Your technicians can cut fabrication time and step up production by wiring sockets instead of circuits.

❀ Your customers will enjoy the satisfaction of superior equipment, the convenience of easier maintenance.

All of which adds up to greater profits, increased customer prestige, and more orders for you.

Standard EECO plug-ins, proven by more than four years' service in some of the nation's largest data systems, are available from stock. Custom units can be readily manufactured to your circuit requirements. Costs are actually below those of standard assembly methods. Write for data file No. A-3.

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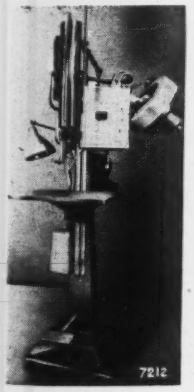
information circle **89** on inquiry card.

NEW INSTRUMENTS

aids, etc. New "dag" copper dispersion is considerably cheaper than other coatings such as silver paint; is more easily applied than copper foil. Application can be by spray or brush (dip coating not recommended). No baking required. Film will air-dry and can be handled within a few minutes. Adhesion can be improved by mechanical pre-treatment (vapor-blasting, sand-blasting, etching, etc.) where necessary.—*Acheson Colloids Co., Port Huron, Mich.*

For more information circle **261** on inquiry card.

SOCKET SET SCREW FEEDER

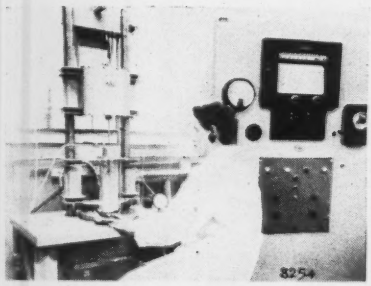


New Socket Set Screw Feeder is for automatic hopper feeding. It automatically feeds and positions standard hex or multiple-spline socket set screws; gives 100% feed to automatic power screw-drivers; can feed up to 45 per minute (limited only by rate at which screwdriver can be operated); can feed socket set screws of various sizes with only finger adjustments for different lengths and feeder-tube changes for different diameters.—*The Bristol Company, Waterbury 20, Conn.*

For more information circle **262** on inquiry card.

SILICON DRAW FURNACE

New silicon draw furnace for producing single-crystal silicon features improved mechanical control of both

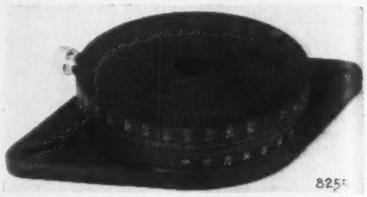


melt and seed. Two assemblies: (1) furnace, comprising a fire box with three motor gearhead assemblies and a pyrometric head; (2) control system, comprising motor control panel and a small remote control box. Use of sapphire rod and thermopile receiver, recording potentiometer and 3-mode automatic control, make possible temperature control of 0.5C° at 1420°C.—*Marvelco Electronics Div., National Aircraft Corp., 3411 Tulare Ave., Burbank, Calif.*

For more information circle **263** on inquiry card.

ROTARY TABLE

New "Mico Cat. No. 640 Four-inch Rotary Table," for circular milling, engraving, or graduating work, has



a ⅜" center hole with ⅝" counterbore accurately located for mounting a work-holding stud or clamp. Top rotates through 360° and has an accurately-graduated scale reading to one minute with vernier.—*Mico Instrument Co., 86 Trowbridge St., Cambridge, Mass.*

For more information circle **264** on inquiry card.

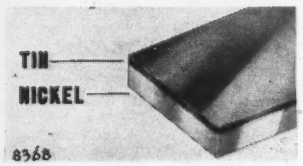
EQUIPMENT FOR AUTOMATIC PRODUCTION OF RESISTORS

New line of automatic resistor-production equipment, developed especially for metal-film and carbon-deposited precision resistors: (1) Basic sorting equipment accurate to better than ±0.5%; sorts resistors without leads into eight resistance categories at a speed of 3600 pieces per hour; is also available for handling components with leads attached; (2) automatic spiraling lathe stops its spiraling function when a preset resistance value is attained; is also available for spiraling resistors with or without leads attached; (3) high-speed dc limit bridge for final testing of completed resistors, accurate to better than ±0.1%; operating speed 5000 pieces per hour. Semi-automatic feeder and storage facilities enable one operator to attend a number of machines. Also available is an adjusting machine for bringing components into final tolerance where this is required.—*Industrial Instruments, Inc., 89 Commerce Rd., Cedar Road, N. J.*

For more information circle **265** on inquiry card.

TIN CLAD NICKEL STRIP

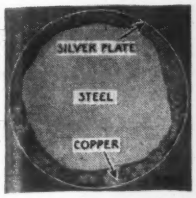
New "Tin Clad Nickel Strip" is a composite metal consisting of pure tin solder clad on one side only to pure



(Type 330) electronic grade nickel. Each layer of metal is of uniform thickness. Metals are inseparably bonded by a solid-phase bonding process without use of brazing alloys or other intermediate material.—*Metals & Controls Corp., General Plate Div., Attleboro, Mass.*

For more information circle **266** on inquiry card.

SILVER-PLATED WIRE

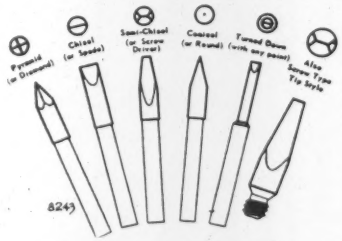


New silver-plated copper or copperweld wire is available in 16 to 20 gage, with plating uniform within 1%. A new low-current-density method of plating produces controlled deposits of silver of 1¼% to 6% by weight. Wire can be redrawn down to 40 gage and maintain same proportion of silver plate as originally deposited.—*Times Wire and Cable Co., Wallingford, Conn.*

For more information circle **267** on inquiry card.

SOLDERING IRON TIPS

New line of "Long-Life Hexclad Soldering Tips" is expanded to 40 stock sizes and shapes. These tips are

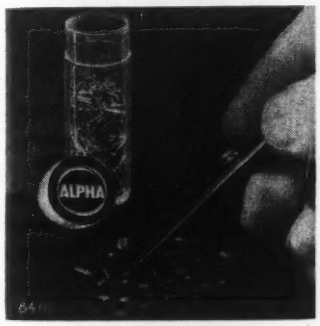


said to "outlast plain copper tips more than ten to one and speed up production."—*Hexacon Electric Co., 295 W. Clay Ave., Roselle Park, N. J.*

For more information circle **268** on inquiry card.

PREFORMED SEMI-CONDUCTOR DOPING ELEMENTS & ALLOYS

New high-purity metals department is ready for full-scale production of all shapes and sizes of the elements

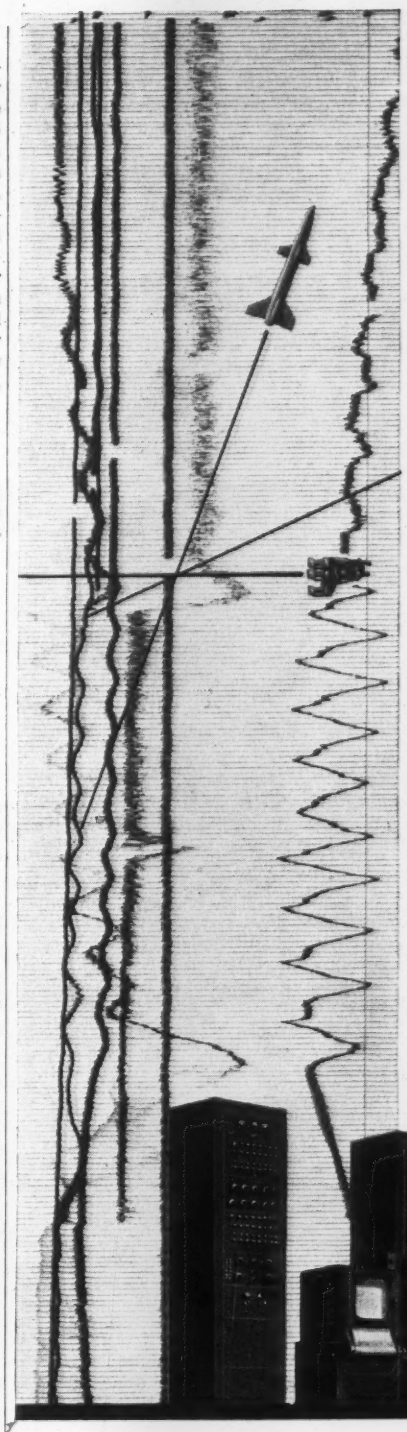


and their alloys found in groups 3 and 5 of the periodic chart, such as gallium, indium, aluminum, antimony and arsenic.—*Alpha Metals, Inc., 56 Water St., Jersey City, N. J.*

For more information circle **269** on inquiry card.

PERMAMENT MAGNETS

New improved specifications for "Indox I Ceramic Permanent Magnets" include an increase in H_c to about 1,700 oersteds, enabling designers to use shorter lengths for a given magnet. B_R also been increased to



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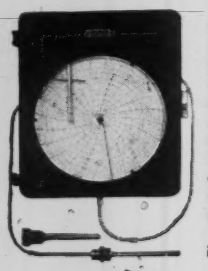

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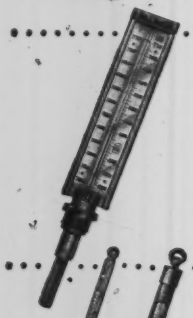
Twelve inch die-cast aluminum case with black or white wrinkle or satin finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges —40 +950°F or Equivalent in °C.



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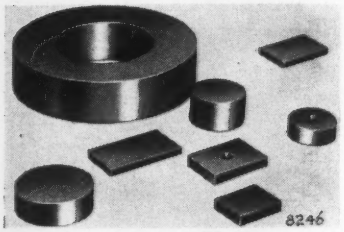
For more information circle **91** on inquiry card.

NEW INSTRUMENTS

about 2,100 gauss, reducing magnet area required to provide desired flux. In addition, BH_{MAX} has been increased to 950,000, permitting savings of magnetic material through greater maximum field energy per unit volume.—*Indiana Steel Products Co., Valparaiso, Ind.*

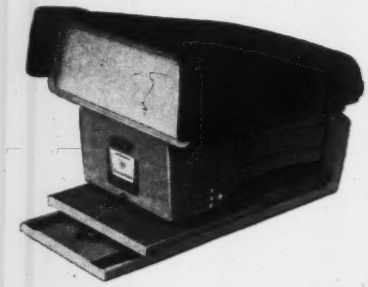
For more information circle **270** on inquiry card.



DIMENSIONAL GAGING, INSPECTION

CONTOUR AND SURFACE PROJECTOR

New "Magnavisa" low-cost self-contained portable projection magnifier is equally suited for fatigue-free



examination of relatively flat objects and small parts, graphic circuits, fine print of small-scale drawings, etc. Two models are available: 3× and 5×; both weigh 18 lb; screen size 4½ x 12"; throat opening 3⅞".—*Instrument Div., American Optical, Buffalo* 15, *N. Y.*

For more information circle **271** on inquiry card.

ELECTRONIC COMPARATOR

New "Accutron" features an electronic gaging circuit unaffected by normal line voltage fluctuations, with

no-drift amplification. Available with standard dual amplifications of 1000/2000; 2500/5000; 5000/10,000; 10,000/20,000 or 20,000/40,000 to 1. Primary element is an "Electrojet" gaging pickup that requires no calibration and can be used with all amplifications. Various accessories available. —*The Sheffield Corp., Dayton* 1, *Ohio.*

For more information circle **272** on inquiry card.

THICKNESS RECORDER

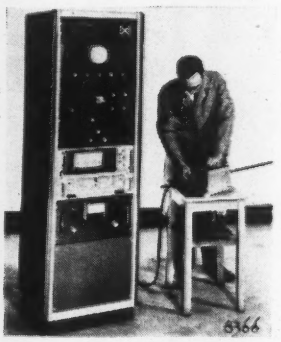
New "Model 493 B-139 Continuous Measuring Recording Gage" checks strip stock as it is feeding to punch

press; can easily be moved from press to press; is deliberately damped so that local irregularities will not show; measures stock from 0.015" to 0.100" thick and from 5" to 18" wide.—*Federal Products Corp.*, 1144 *Eddy St., Providence* 1, *R. I.*

For more information circle **273** on inquiry card.

AUTOMATIC INSPECTOR FOR WIRE, ROD, TUBE, ETC.

New "Magnatest FW-400" inspection unit for non-magnetic rod, wire, tube, and bar automatically detects

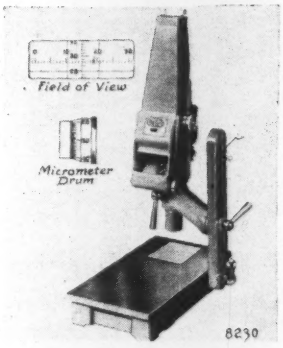


seams, overlapping, diameter changes, inclusions, voids, concentrated porosity, metallurgical variation, and splits; can operate at speeds in excess of 300 fpm and can be equipped with signalling and recording devices.—*Magnaflux Corp.*, 7300 *W. Lawrence Ave., Chicago* 31, *Ill.*

For more information circle **274** on inquiry card.

MICROMETER-COLLIMATOR

New model of "Projection Angle Dekkor" (made by Hilger & Watts, England) is equipped with an optical micrometer for direct reading to ½ second; determines squareness, paral-



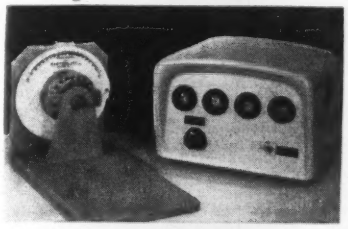
lelism, tilt, and change of angle, regardless of distance.—*Engis Equipment Co.*, 431 *S. Dearborn St., Chicago 5, Ill.*

For more information circle **275** on inquiry card.

MECHANICAL TESTING

DYNAMOMETERS

New complete line of motor-testing dynamometers features maker's new electronic tachometer (right). System



of torque indication is independent of speed, rotor bearing friction and external sources of mechanical or electrical error. Moreover, no error due to tachometer generator because photoelectric pickup requires no driving torque.—*Magtrol, Inc.*, 38 *Virginia Place, Buffalo 2, N. Y.*

For more information circle **276** on inquiry card.

HIGH-FREQUENCY VIBRATOR

New "Hydrashaker" utilizes electronically actuated hydraulic power amplification; provides accelerations up to 100G with 0.2" total displacement; 20,000-lb block force; useful frequency range of 5 to 2,000 cps. It is said that "only 15% of available force is expended by the Hydrashaker for driving its 30-pound moving assembly to 100-G, leaving ample force for testing missile or aircraft structures and their components."—*Wyle Mfg. Corp.*, 124 *Maryland St., El Segumdo, Calif.*

For more information circle **277** on inquiry card.

STRAIN-GAGE RECORDERS

New models of maker's 50-point automatic scanning recorders for "SR-4" strain gages have been improved four ways: (1) For either two-arm or four-arm strain gage bridges; (2) 0-1000 microinch range

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The new Model DDL is a compact, potentiometer-type accelerometer designed specifically for use as a sensing instrument in high-speed aircraft flight control systems. It is now in use on America's fastest operational jet fighter.

The DDL is basically a low range instrument available in ranges between ±0.1 g and ±7.5 g's, inclusive. The standard instrument will operate to specifications in a temperature environment from −65° F. to +185° F; however, if desired, the instrument can be modified to operate in an environment as low as −100° F. or as high as +275° F. Dual potentiometer output is also obtainable on request.

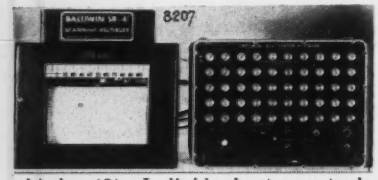
Although damping is accomplished magnetically, the case is filled with oil to reduce internal resonances, permitting the instrument to operate to specifications in severe vibrational environments. Damping and natural frequency are independent of the instrument position.

Send for complete specifications.

Genisco INCORPORATED

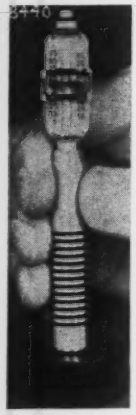
2233 Federal Ave., Los Angeles 64, Calif.

For more information circle **93** on inquiry card.



added; (3) Individual stress-strain curves can be plotted automatically for each channel; (4) Skipping mechanism conserves chart paper when fewer than 50 channels are being scanned.—*Electronics & Instrumentation Div., Baldwin-Lima-Hamilton Corp., 806 Massachusetts Ave., Cambridge 39, Mass.*

For more information circle **278** on inquiry card.



POCKET HARDNESS TESTER

New "Rex Model A," for use in measuring hardness of rubber, plastics, etc., indicates hardness in Durometer units that comply with ASTM specs for rubber hardness. Vernier reads to 5 points, permits interpolation to about 2 points with average vision. (With magnifier, even more closely.)—*W. F. Orth, 802 S. Ada St., Chicago 7, Ill.*

For more information circle **279** on inquiry card.

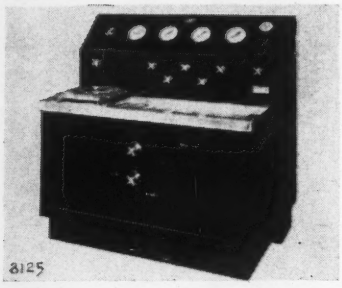
TORQUE WRENCH TESTER

New torque wrench calibrator facilitates setting and checking of all types of hand torque wrenches (right or left hand); is certified to be accurate within 1% of full-scale reading. Model shown weighs 6 lb, is 7 1/2" high; mounts on bench or clamps in vise; checks torque from 0 to 30 pound feet. Other models for torques from a few pound-inches to 2000 pound-feet. —*Skidmore-Wilhelm Mfg. Co., 442 Green Road, Cleveland 21, Ohio.*

For more information circle **280** on inquiry card.

SAFETY VALVE TEST STAND

New "packaged" safety valve test stand can be used for the regular setting and checking of all types of safety valves from ¼" screwed to 4" flanged. Model shown is for pressures between 0 and 1000 psi; other models

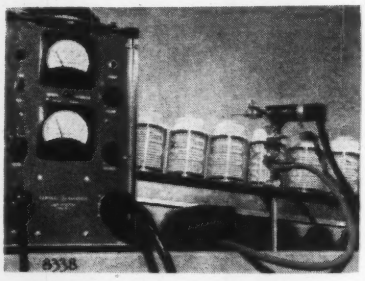


available for ranges to 10,000 psi.—*Industrial Engineering Corp., 525 East Woodbine, Louisville 8, Ky.*

For more information circle **281** on inquiry card.

LEAK DETECTOR

New modification of "Type H-1 Leak Detector" enables automatic high-production leak testing at low



cost. Hand-held "gun" of standard model has been replaced with a fixed head for attachment to conveyor belt. Leak defects are indicated visually and/or audibly. It is possible to remove defective items automatically.—*General Electric Co., Schenectady 5, N. Y.*

For more information circle **282** on inquiry card.

LEAK-DETECTOR TESTER

New "Halogen Leak Standard," said to make possible "for the first time inexpensive quantitative leak checking," is for precise calibration of halogen-type leak detectors. It is ad-

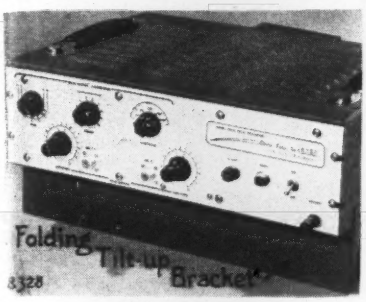
justed to desired leak rate value and detector's probe is inserted into gun fitting: output indicator then shows appropriate reading.—*Instrument Dep't., General Electric Co., 40 Federal St., West Lynn, Mass.*

For more information circle **283** on inquiry card.

ELECTRICAL TESTING

PULSE OSCILLATOR

New "Model 3420B" wide-range trigger generator produces pulses at repetition rates from 100 cps to 3.3



Mc. Two separate blocking oscillator output pulses (each available + or −) are provided in a half-period relationship enabling, by mixing, such waveforms as alternate positive and negative pulses. Output pulses are about 0.1 usec wide from an impedance level of less than 250 ohms, and with amplitude variable to 25 v open circuit.—*Electro-Pulse, Inc.*, 11861 *Teale St., Culver City, Calif.*

For more information circle **284** on inquiry card.

PULSE GENERATOR

New "Type 404," second in maker's advanced-styling "Series 400" instruments, features excellent pulse rise-

time (0.018 usec) and low overshoot specifications, a high-precision output attenuator, 100-kc pulse repetition rate ("20 times higher than any comparable instrument on the market"), and automatic overload protection. Pulse width variable from 0.05 usec to 100 usec. Push-button attenuation switch allows attenuation in ½-db steps up to 60 db.—*Allen B. Du Mont Labs, Inc., 760 Bloomfield Ave., Clifton, N. J.*

For more information circle **285** on inquiry card.

TV TESTER

New "Model 382" multipurpose flyback combines an in-circuit horizontal system analyzer and a capacitor checker; will check an entire TV horizontal deflection system in-circuit, test flyback transformers for opens and shorts, check deflection yokes

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SERVOMOTOR-TACHOMETER GENERATOR

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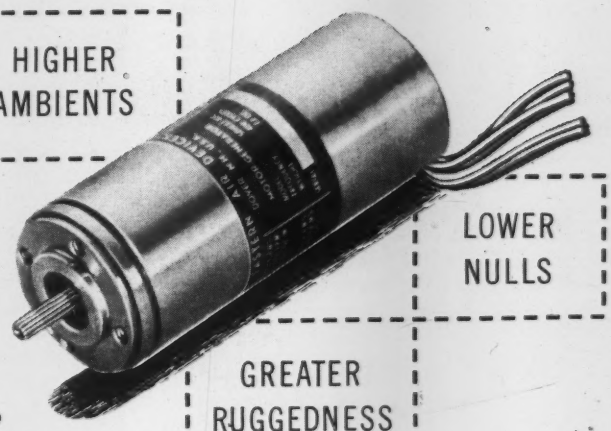

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For more information circle **94** on inquiry card.

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. . . . "the quality or state of being precise; accuracy; mechanical exactness."

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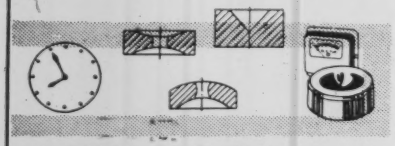

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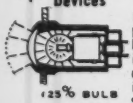

Since most conventional indicator lights bulbs are located behind the panel they have to make use of bulky magnifying lenses or refracting devices. But the bulb-lens unit on the Alden "Pan-i-Lite" mounts in front of the panel — needs no special lens to provide a brilliant glow that is . . .

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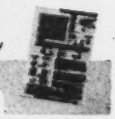
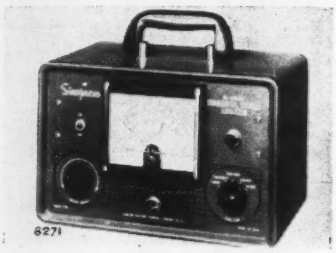


For more information circle **96** on inquiry card.

NEW INSTRUMENTS

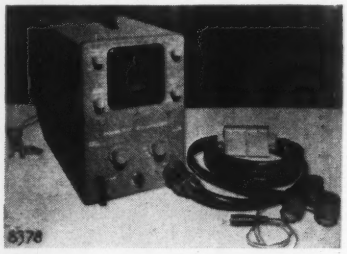


for opens and shorts, measure capacitances from 10 mmf to 0.1 mfd by direct reading.—*Simpson Electric Co., 5200 W. Kinzie St., Chicago, Ill.*

For more information circle **286** on inquiry card.

TROUBLE-SHOOTING ANALYZER

New "Model 141-A" is designed to quickly check-out operation of most Brown "ElectroniK" continuous-bal-

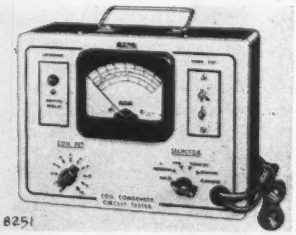


ance amplifier units. It comprises an oscilloscope and adapter cable; is connected through tube socket plug adapters without disturbing either input or output amplifier connections. In most cases indicated repairs can be made with amplifier in place. Step-by-step instructions are included.—*Parameters, Inc., 195 Herricks Road, New Hyde Park, N. Y.*

For more information circle **287** on inquiry card.

IGNITION ANALYZER

New "Model G-222 Universal Coil-Condenser-Circuit Tester" serves dual purpose of testing both 6- and 12-v

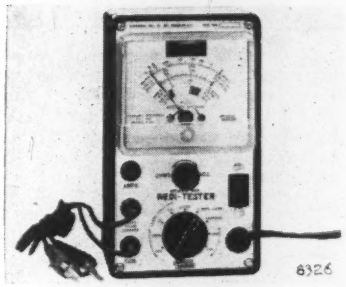


battery-ignition and magneto coils, plus all types of condensers; also provides high voltage for locating insulation breakdowns, and shorts.—*King Electric Equipment Co., 9123 Inman Ave., Cleveland 5, Ohio.*

For more information circle **288** on inquiry card.

HOME REPAIRS TESTER

New "Model 540 Redi-Tester" is said to be such that "the do-it-yourself-er becomes a one-man complete



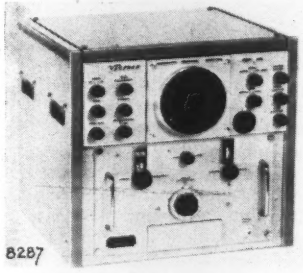
electrical and electronic servicing department for home and automotive repairs." Available in kit or wired form.—*Eico, 84 Withers St., Brooklyn 11, N. Y.*

For more information circle **289** on inquiry card.

ELECTRICAL INSTRUMENTS

MICROWAVE SPECTRUM ANALYZER

New "Model SA30X5" provides precision coverage of 8500 to 9660 Mc (most used portion of X band). A

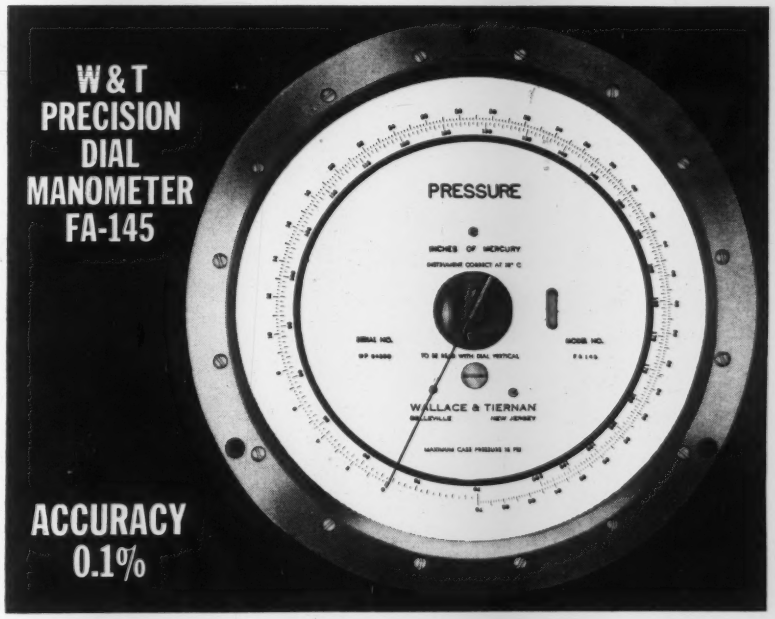


direct-reading klystron tuning dial, and a wavemeter calibrated in actual signal frequency, give it both speed and accuracy. Available for standard rack mounting or as a portable weighing less than 80 lb.—*Vectron, Inc., 1573 Trapelo Road Waltham 54, Mass.*

For more information circle **290** on inquiry card.

CATHODE-RAY OSCILLOSCOPE

New "Type 401," first of maker's advanced-styling "Series 400" instruments, features "a new freedom from annoying mechanics of instrument operation." Completely redesigned



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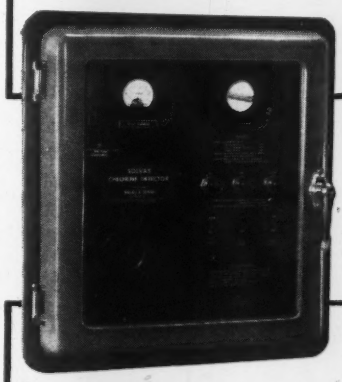

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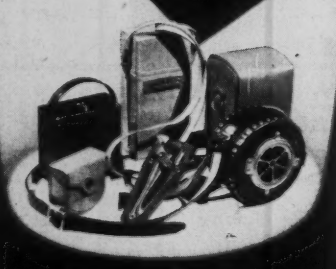

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For more information circle **99** on inquiry card.

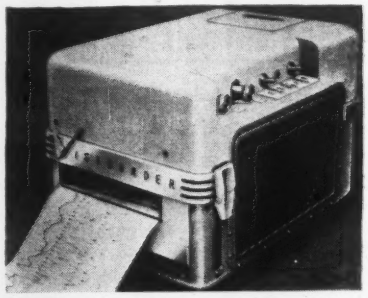
NEW INSTRUMENTS

front panel is divided into visual and manual areas by use of an offset cast frame, new lettering styles, and new control knobs and rearranged groupings of these knobs in basic functional blocks in sharp, contrasting colors. A unique read-out system on calibration controls is said to make new CRO "practically a digital device for reading amplitude and time."—*Allen B. Du Mont Labs, Inc., 760 Bloomfield Ave., Clifton, N. J.*

For more information circle **291** on inquiry card.

OSCILLOGRAPH

New "Visicorder" is said to combine high-frequency and sensitivity characteristics of photographic oscillo-

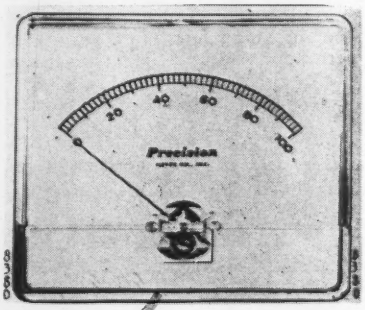


graphs with convenience of a direct-writing instrument. Its galvanometers' sensitivity is comparable to that in photographic-type oscillographs, yet record is instantly visible, readable and usable without further processing. Its 2,000-cps flat frequency response is achieved without "peaked" amplifiers or other compensation. It accommodates as many as six channels on a 6" chart. Its galvanometers deflect a full 6" peak to peak: traces can overlap. Chart speeds 0.2, 1, 5 and 25" per second, minute or hour. —*Heiland Div., Minneapolis-Honeywell Regulator Co., 5200 E. Evans Ave., Denver 22, Colo.*

For more information circle **292** on inquiry card.

PANEL INSTRUMENTS

New indicating electrical instruments feature a new design; are avail-

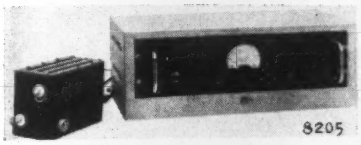


able for all applications; in molded Bakelite or molded plastic, 4½" and 3½" sizes.—*Precision Meter Co., 126 Greenpoint Ave., Brooklyn 22, N. Y.*

For more information circle **293** on inquiry card.

ELECTROMETER SYSTEM

"EKCO Model 1079C Vibrating Reed Electrometer," for critical measurement of small direct currents and

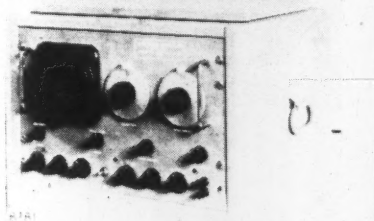


voltages at high impedance, as encountered in radioactivity, pH studies, etc., was originally designed by British Atomic Energy Establishment; utilizes a true resonant reed type of capacitor which makes it inherently free from driving voltage fluctuations. Sensitivity 0.03 uua full-scale reading at maximum; ranges 0-30, 0-100, 0-300, 0-1000 mv; output operates 1 ma or 100 mv recorder.—*American Tradair Corp.*, 34-01 30*th Street, Long Island City* 6, *N. Y.*

For more information circle **294** on inquiry card.

SPECTRUM ANALYZER

New "Model SS-100" 0-100-kc wideband spectrum analyzer gives an instantaneous Fourier analysis of noise

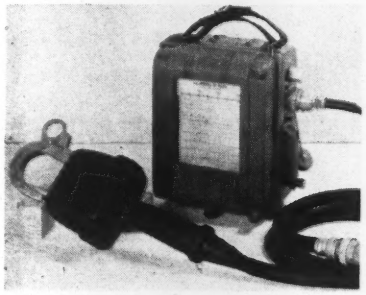


vibration and harmonics for telemetering, aircraft, filter, acoustic, and medical fields. Features include automatic optimal resolution, bandpass input filter, continuously-variable center-frequency and sweep-width controls, camera mount bezel, 60-db dynamic range, linear and 3 decade log voltage scale with 1 db accuracy, and 500-uv to 500 v full scale input range. —*Probescope Co.*, 44-05 30*th Ave., Long Island City* 3, *N. Y.*

For more information circle **295** on inquiry card.

HOOK-ON VOLT-AMMETER

New "Type CF-7" has had two standard ranges added: 30 and 300 amp. This provides a recorder with these ranges: 15, 30, 75, 150, 300, 750 amp; 150, 300, and 750 vac. It



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P.A. STURTEVANT CO.
For more information circle **103** on inquiry card.

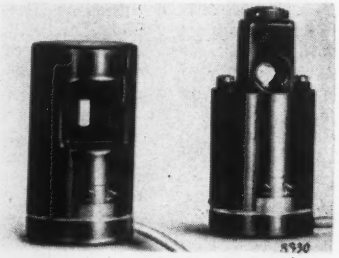
NEW INSTRUMENTS

combines a Butyl-molded hook-on current transformer insulated for an ASA rating of 8700 v and a "CF" inkless recorder.—*General Electric Co., Schenectady 5, N. Y.*

For more information circle **296** on inquiry card.

GALVANOMETERS

New "H&B Measuring Movements" are German-made rapidly-oscillating moving coil galvanometers with con-



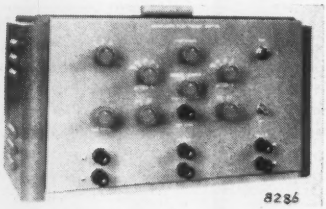
cave reflecting mirrors 7 mm dia, focal distance 75 mm. Flat mirrors or mirrors with other focal distance are also obtainable. Various models are available with inherent frequency from 1 cps to 570 cps and with sensitivities from 0.0036 to 252 microamp per mm at 1 m distance; damped by external resistance or by silicon oil. —*E P I C Inc.*, 154 *Nassau St., New York 38, N. Y.*

For more information circle **297** on inquiry card.

ELECTR-INSTRUMENT ACCESSORIES

ELECTRONIC SWITCH

New "Model ES-17" permits simultaneous observation of two signals on one 'scope; provides a wide range of



frequency response (to 4 Mc) in conjunction with a useful magnitude of amplification. Short transfer time eliminates visible transfer of images. Wide range of input signals: amplitudes from 10 mv rms to 200 v rms. —*Vanguard Instruments Corp.*, 184 *Casper St., Valley Stream, N. Y.*

For more information circle **298** on inquiry card.

OSCILLOGRAPH EXPLOSION-PROOFING & FLASH TIMING

New optional features on maker's "Type 5-119 Recording Oscillograph" are explosion-proofing for airborne applications and a flash timing system for absolute synchronization of

multiple oscillograph installations. Explosion-proof model is for 400-cps 200-v 3-phase operation only. Flash timing system permits absolute timing through an internal or external pulse source; is designed to synchronize timing lines from 2 to 100 remotely-located oscillographs. With it, master units can control up to ten slaves. Up to 100 units can be slaved by adding a cathode follower to system.—*Consolidated Electrodynamics Corp., 300 North Sierra Madre Villa, Pasadena, Calif.*

For more information circle **299** on inquiry card.

LOGARITHMIC CONVERTER

New "Model 60," for use with maker's "Autograf" *X-Y* recorder in applications where dc output voltages

proportional to log of input voltages are required, is available for ac or dc inputs. Logarithmic output voltage provides *Y* function for plotting curves in which *X* axis may represent various controlled values. Advantage of log conversion: wide ranges of level that can be plotted with maximum accuracy at low amplitudes.—*F. L. Moseley Co., 409 N. Fair Oaks Ave., Pasadena, Calif.*

For more information circle **300** on inquiry card.

OUTDOOR TRANSFORMERS

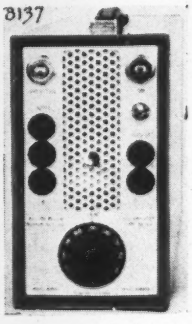
New "JKW-4" 8700-v instrument transformer completes maker's butyl-molded "CT" family, ranging from a 600-v miniature to a 15,000-v outdoor model; is designed for outdoor services and is suitable for operating instruments, meters, relays and control devices. It replaces "JKB-4" and "JK-10" and is about half their size and weight.—*General Electric Co., Schenectady 5, N. Y.*

For more information circle **301** on inquiry card.

AMPLIFIERS

DC AMPLIFIER

New "DC-6A" is stabilized for drift and gain over frequency range from dc to 30,000 cps; comes complete with power supply for operation on 115 vac. When suitably ventilated, as many as 5 amplifiers can be mounted side by side in a standard relay rack. Gain before feedback 10^6; attenuation is



Giannini
ROTOSTEPPER

Pulse-to-shaft Position Converter

Powerful, rapid, absolutely controllable shaft rotation in precise 2° increments... for DC pulse-to-analog shaft positioning in computers, sequence switching, algebraic counting, remote shaft positioning.

Pulsed DC from hand operated switches, choppers, or any similar manual or automatic pulsing devices controls the Giannini Rotostepper in precise 2° angles of rotation .... unlimited in either direction, at the rate of one step per pulse.

Optional control mechanisms available on the versatile Rotostepper provide homing to a fixed reference angle, automatic continuous stepping with a steady DC voltage, and/or potentiometric divided voltage functional to shaft position.

SPECIFICATIONS:

TORQUE: Up to 14 oz-in
SPEED: Up to 60 steps per second
ROTATION: Unlimited CW or CCW in 2° increments
LOCK: Spring detent locks shaft in a position accurate to ±6'
INPUT: 28 volts DC, 10 milliseconds minimum duration per step

Giannini
PRECISION INSTRUMENTS & CONTROLS

For further information write for Rotostepper Bulletin 8915A

G. M. GIANNINI & CO., INC., 918 E. GREEN ST., PASADENA, CALIF.

For more information circle **104** on inquiry card.

• high voltage silicon diodes
• piv range—600 to 1000 volts
• high reliability and quality

style #

SILICON DIODES

Designed for applications where high inverse voltage ratings, superior rectification efficiency and small unit size are required. Write for descriptive Bulletin SR 138B today.

• TEMPERATURE OPERATING RANGE —55°C to +150°C
• OPTIMUM RELIABILITY AT ELEVATED AND SUB-ZERO TEMPERATURES
• HERMETICALLY SEALED

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For more information circle **105** on inquiry card.

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DUCTILE BISMUTH WIRE

with all the advantages of bismuth—yet

- **Pliable**
- **Ductile**
- **Will not age—harden or crystallize as regular extruded bismuth.**
- **Has tensile strength to 2500 psi**

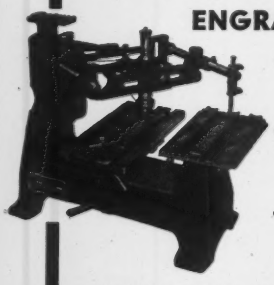
BISMUTH is the most diamagnetic of all metals; has highest Hall coefficient for ductile metals; has greatest resistance change in a magnetic field; has greatest resistance of pure ductile metals per mil ft.; has lowest thermal capacity; has least thermal conductivity; has highest negative thermocouple voltage per degree change; has most rapid thermocouple response; an alloy (symbol "A") has highest positive thermocouple voltage.

DUCTILE BISMUTH WIRE has all of these advantages in addition to the ones listed above. Our special process has made the bismuth more pliable and ductile without changing the basic physical properties.

Fitzpatrick Electric Supply Co.
444 Irwin St. Muskegon, Mich.

For more information circle **106** on inquiry card.

PREIS-PANTO ENGRAVER



- Ratios from 1.6:1 to 7:1
- Areas at 2:1 ratio —4-5/16" sq. 4½" circle
- Areas at 7:1 ratio —1⅛" sq. 1⅜" circle

A high precision, sturdily constructed, widely adaptable machine for engraving steel stamps, dies, other metals, plastics, fibre, wood, etc.

By simple attachment of additional accessories this machine may also be used for ELECTRICAL MARKING and ACID ETCHING.

Several models available for 2 and 3 dimensional engraving.

Write for NEW Bulletin B-2 of the complete line and ask for catalog UE-3 with price lists.

TRADE MARK PANTO

For immediate attention write directly to manufacturer below. Ask for nearest representative.

H. P. PREIS Engraving Machine Co.
661 U.S. Highway 22 Hillside, N. J.

For more information circle **107** on inquiry card.

NEW INSTRUMENTS

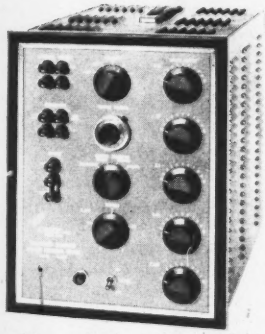
made in feedback circuit gain to permit optimum signal to noise ratio for all settings. Eleven gain steps from 0 to 1000. Linearity better than 0.25% of full scale for any gain setting in range dc to 2000 cps.—*Wm. Miller Instruments, Inc.* 325 *N. Halstead Ave., Pasadena* 8, *Calif.*

For more information circle **302** on inquiry card.

POWER SUPPLIES

VOLTAGE REFERENCE

New "Model VR-607 Secondary Standard Voltage-Reference Source" has 0.01% absolute accuracy and 10

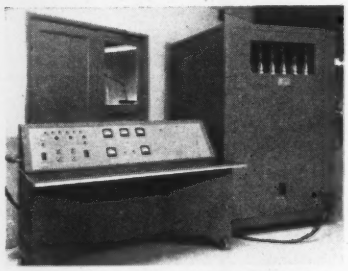


microvolt resolution. It combines a dc voltage source with five decade switches as incremental voltage dividers. Continuous dc reference outputs of ±100.00 v have maximum drift of 0.02% per year. Output voltage is selectable between +111.112 and −111.112 in discrete steps of 1 mv. Portable (shown) or 14" size for standard rack mounting.—*Epsco, Inc.*, 588 *Commonwealth Ave., Boston* 16, *Mass.*

For more information circle **303** on inquiry card.

20-KV 3-AMP SUPPLY

New "Model PC 45," developed for powering 20-kw c-w klystrons, provides 0-to-20 kvdc at currents up to 3

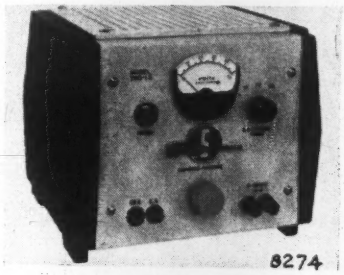


amp with less than 1% ripple; is operated from remote-control console shown. Instruments for measuring beam voltage, beam current, collector current and body current are provided. Unit is completely protected.—*Levinthal Electronic Products, Inc.*, 2905 *Fair Oaks Ave., Redwood City, Calif.*

For more information circle **304** on inquiry card.

TRANSISTOR SUPPLY

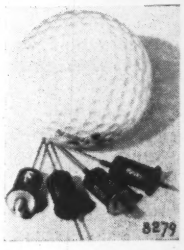
New "T-Nobatron Model T-50-1.5," especially designed for transistor circuit work, features excellent line voltage regulation and transient response for line and load pulses. Input range 95-130 vac, 60 cps; three output ranges, 0-10, 0-25, and 0-50 v.—*Sorenson & Co., Inc., 375 Fairfield Ave., Stamford, Conn.*



For more information circle **305** on inquiry card.

RECTIFIERS

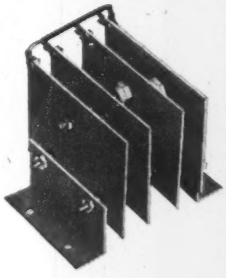
SILICON RECTIFIERS



Four new production types of 1500-v single-element grown-junction rectifiers feature welded case construction and highest operating voltage commercially available. Two axial models, "IN588" and "1N589," allow point-to-point wiring; two stud models, "1N590" and "1N591," maximize heat dissipation.—*Texas Instruments Inc., 6000 Lemmon Ave., Dallas 9, Texas.*

For more information circle **306** on inquiry card.

SILICON RECTIFIER



New silicon power rectifier, said to have "many advantages over the selenium rectifier," features 99% efficiency, 4% regulation, high forward current with low voltage drop and low reverse current "which gives it magnetic amplifier quality"; operating temperature to 190°C and 120°C ambient and high operating voltage (up to 600 PIV).—*Sanford Miller Co., 691 Bedford Ave., Brooklyn, N. Y.*

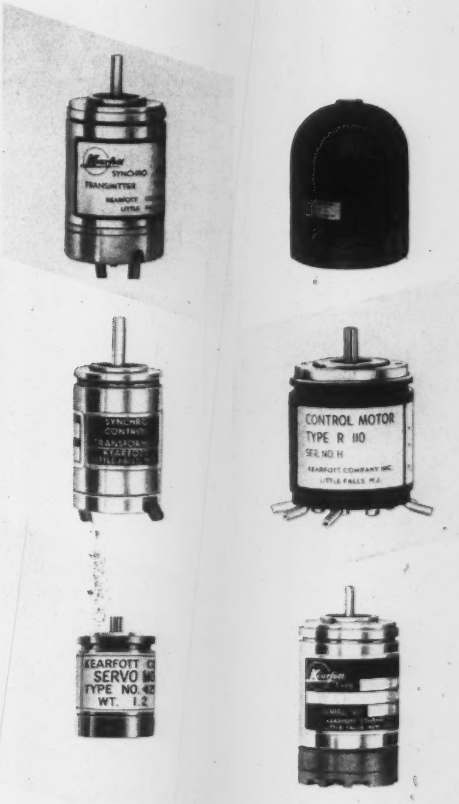
For more information circle **307** on inquiry card.

600-V RECTIFIER STACKS

New 600-v silicon rectifier stacks are available in all circuit types with rms inverse voltage ratings of 70 to

Kearfott Components

FOR EVERY SYSTEM APPLICATION



KEARFOTT offers the systems manufacturer the most complete line of precision made components available anywhere. Quantity production enables quick deliveries and reasonable prices.

SYNCHROS—Transmitters, Control Transformers, Resolvers, Repeaters, and Differentials in Bu Ord Sizes 8, 11 and 15. High Accuracy and environmental resistance.

SERVO MOTORS—High torque, low inertia Servo Motors, Inertial and Viscous damped Servo Motors, in Bu Ord Sizes 8, 11, 15, 18 and 23.

TACHOMETER GENERATORS—Available as damping generators, rate generators and integrators. They feature high output to null ratio and extremely linear outputs. Temperature stabilization may be provided.

GYROS—Directional, floated rate integrating, free, vertical, and spring restrained rate gyros for all airborne navigation, stabilization or fire control applications.

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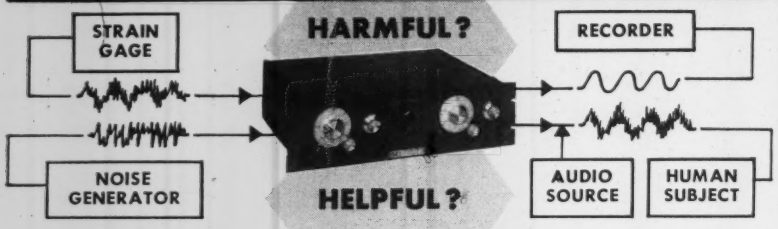
For more information circle **108** on inquiry card.

NOISE MASKING



HANDLE BOTH PROBLEMS WITH SKL VARIABLE FILTERS

HELPFUL

SKL Electronic Filters are used constantly in acoustic, speech and psychology laboratories to shape bands of noise over a wide spectrum for measurements of masking effect in research on annoyance threshold judgments, loudness adaptation, sonar audibility, etc.

HARMFUL

SKL Electronic Filters are widely used in vibration, telemetering, underwater sound and cardiography studies to eliminate interfering hash and unwanted frequencies in the outputs of all kinds of transducers such as microphones, accelerometers, hot wire anemometers, hydrophones, etc.

Why not let SKL Series 300 Variable Electronic Filters solve your problem too? Write for data sheets.

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For more information circle **109** on inquiry card.

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★
of all Nylon
for severe conditions
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molded Black Nylon
SCREWS and NUTS
★ Acid resistant
★ Need no insulation
★ Can't rust
★ Can't corrode

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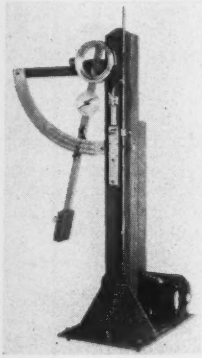
For more information circle **110** on inquiry card.

AMTHOR
Tensile Strength Testers

Amthor Tensile Strength Testers are designed and constructed in strict conformity with the latest specifications as approved by recognized Testing Committees. New and



improved features are included, which simplify operation and insure an extremely high degree of accuracy. Suitable for materials such as papers, twine, wire, plastics, aluminum foil, tapes, etc. Many models in capacities from 25 lbs. to 1500 lbs. available.

Write for literature to:

Amthor Testing Instrument Co., Inc.
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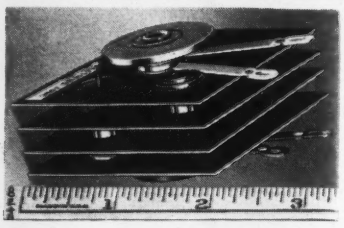
Brooklyn, N. Y.

For more information circle **111** on inquiry card.

NEW INSTRUMENTS



420 v, with output dc up to 4.5 amp at 75°C ambient temperature; can be arranged in series and parallel to increase voltage or current ratings. To insure freedom from contamination, silicon junctions are hermetically sealed.—*International Rectifier Corp., El Segundo, Calif.*

For more information circle **308** on inquiry card.

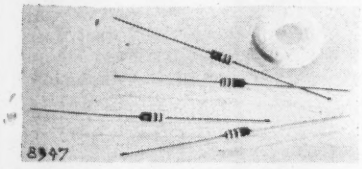
SILICON RECTIFIERS

Three new 165°C low-current silicon rectifiers meet stringent military requirements; are priced at about same level as other rectifiers of equal ratings. Designated "1N536, 1N539 and 1N540," are rated respectively at maximum peak inverse voltages of 50, 300 and 400; maximum allowable rms voltages 35, 210 and 280.—*General Electric Co., Electronics Park, Syracuse, N. Y.*

For more information circle **309** on inquiry card.

SILICON JUNCTION DIODES

New quick-recovery silicon junction diodes, "1N625, 1N626, 1N627, 1N628, and 1N629," combine high speed, plus

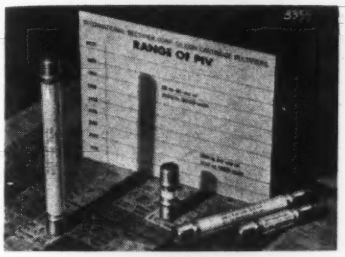


high voltage, plus high temperature—a combination "not heretofore available in subminiature semiconductor devices." All types are packaged in a one-piece, fusion-sealed glass envelope.—*Hughes Products, International Airport Station, Los Angeles 45, Calif.*

For more information circle **310** on inquiry card.

16,000-V SILICON DIODES

New high-voltage silicon rectifiers are especially designed for power applications where high ambient temperature, reliability, high efficiency and miniaturization are required. Available in production quantities with ratings from 600 v at 100 ma half-wave

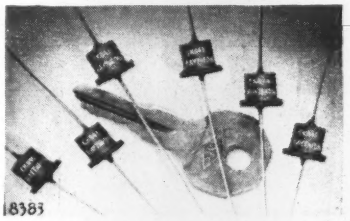


dc output to 16,000 v PIV at 45 ma; high rectification efficiency over operating ambient temperature range of minus 55°C to 150°C.—*International Rectifier Corp., El Segundo, Calif.*

For more information circle **311** on inquiry card.

DIFFUSION-PROCESS DIODES

Six new types (CK840 to CK845) are the first solid state diffused junction silicon diodes to be made avail-



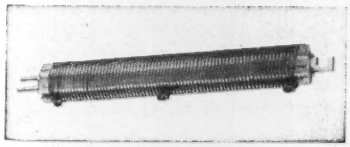
able in production quantities. Diffusion process permits precise control of junction and thus assures more and dependable diodes. Characteristics at 100°C: peak inverse voltage 100 to 600 in steps of 100; reverse current at PIV 0.2 ma max; forward current 350 ma max; forward voltage drop at 350 ma 0.75 v.—*Raytheon Mfg. Co., 55 Chapel St., Newton 58, Mass.*

For more information circle **312** on inquiry card.

RESISTORS

POWER RESISTORS

New "Round-Wire Type, Powr-Rib" resistors for high-current, low resistance applications consist of ceramic



insulators assembled on a metal bar and wound with resistance alloy wire. Four lengths; resistance values from 0.69 to 25 ohms; current ratings from 5.1 to 18.4 amp.—*Ohmite Mfg. Co., 3649 Howard Street, Skokie, Illinois.*

For more information circle **313** on inquiry card.

TRIMMER VDR

New "Model 205 Trimpot" voltage-dividing resistor is a subminiature unit with round-pin terminals for

DIEHL

Instrument Servo Motors with Tachometer Generators and Gear Reducers

Two phase 60 cycle servo motor designed with high torque-to-inertia ratio furnished with either high or low impedances for use with transistor, vacuum tube or magnetic amplifiers.

Providing three servo system components that can be obtained separately or in any combination. Built to meet high humidity requirements but competitively priced for commercial application.

Servo motor with gear reducer offers five different ratios. Rugged spur gear construction can carry a continuous load torque of 90 oz. inches.

Servo motor with AC tachometer generator provides an easy adjustment to stabilize the system. Residual voltage of 100 millivolts with 115 volt excitation.

Servo motor with gear reducer and AC tachometer forms a convenient package of three components ready for your application.

Diehl design and engineering staff will be happy to help any manufacturer in the selection of designed-for-the-job combinations of Instrument Servo Motors and ancillary units.

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Please mail Manual RPT-355, describing Diehl Servo Motors and related equipment.

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For more information circle **112** on inquiry card.

Why "CHOKE" your soldering iron?

— just "CRADLE" it with a

HEXACON
HATCHET SOLDERING IRON

The operator has to "choke" the conventional straight iron to hold it, whereas the HEXACON HATCHET IRON "cradles" in the hand with no perceptible grip whatsoever — *thus relieving hand strain* and eliminating the "heavy hand", the cause of poorly soldered joints. Because HEXACON HATCHET IRONS are *perfectly balanced* in weight, they enable the operator to solder in a natural position and relieve fatigue of arm and back.

Send for new circular No. 70H giving more details and comparative competitive performance data.

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506 West Clay Ave., Roselle Park, New Jersey

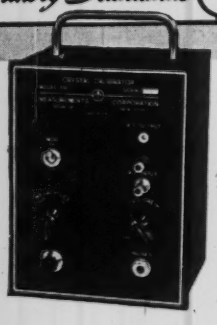
A COMPLETE LINE OF HATCHET IRONS BY HEXACON —Originator and Pioneer

CAT. NO.	WATTS	TIP DIA.	PRICE
25H	25	1/8"	$ 6.50
26H	30	3/16"	6.50
30H	60	1/4"	6.75
70H	80	3/8"	11.00
100H	100	3/8"	12.00
150H	150	3/8"	12.75
151H	175	1/2"	13.50
200H	200	5/8"	14.00
300H	300	7/8"	18.25

INDUSTRY'S No 1 HEXACON SOLDERING IRON

For more information circle **113** on inquiry card.

Laboratory Standards



CRYSTAL CALIBRATOR

For calibration and frequency checking of signal generators, transmitters, receivers, griddip meters, and other equipment where a high degree of frequency accuracy is required.

Frequency Range
Model 111 - 250 Kc to 1000 Mc
Model 111-B-100 Kc to 1000 Mc
Frequency Accuracy ±0.002%
Write for Bulletin 160

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BOONTON • NEW JERSEY

For more information circle **114** on inquiry card.

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Liberal relocation allowances for you and your family plus other emoluments.

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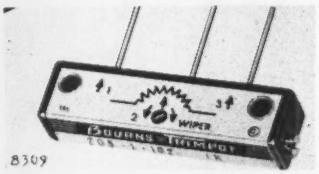
NEW INSTRUMENTS

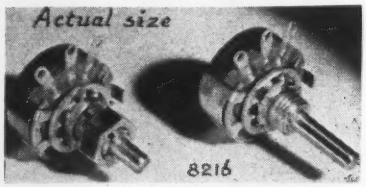


printed circuit applications; will dissipate 0.25 watts at 50°C; maximum operating temperature 105°C. In all other design features it is similar to "Model 130."—*Bourns Laboratories, Inc.*, 6135 *Magnolia Ave., Riverside, Calif.*

For more information circle **314** on inquiry card.

CONTROL RESISTOR

New "Model 3 Radiohm," 0.671" dia, rated ¼ watt at 70°C, is a versatile miniaturized control designed



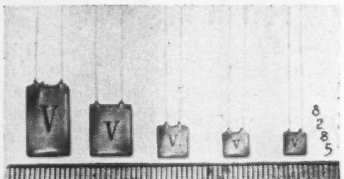
to meet rugged military specifications; well suited for miniature amplifier, telephone and carrier systems, test and geophysical equipment, etc. Resistance range 500 ohms to 2.5 megohms.—*Centralab*, 900 *E. Keefe Ave., Milwaukee* 1, *Wis.*

For more information circle **315** on inquiry card.

CAPACITORS

CERAMIC CAPACITORS

New "Valcap 2000K Series" subminiature extended temperature range ceramic capacitors maintain

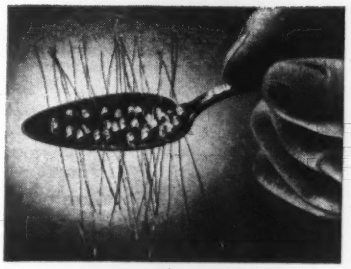


over 90% of capacitance through temperatures ranging from —55° to 125°C; are rated at 200 working vdc as compared to a more usual rating of 25 to 50 wvdc for comparable size.—*Valco Engineering Sales Co.*, 2538 *So. Highland Ave., Los Angeles* 16, *Calif.*

For more information circle **316** on inquiry card.

TANTALUM CAPACITOR

New "Size M Tan-O-Mite," latest addition to "Series TW" tantalum capacitor line, is only 0.095" dia. by 11/64" long; capacitance range 0.02 to 4 mfd. Illustration: partly filled



teaspoon of these units add up to 432 microfarads. Usuable temperature range, −55°C to 85°C, exceeds rated limits of other similar capacitors.—*Ohmite Mfg. Co., 3639 Howard St., Skokie, Ill.*

For more information circle **317** on inquiry card.

ELECTRONIC COMPONENTS

JUNCTION TRANSISTOR

New "GT-109" germanium *p-n-p* alloyed junction 3-lead transistor, designed primarily for use in low frequency push-pull stages, in class B circuitry, offers high efficiency and low battery drain.—*General Transistor Corp., 130-11 90th Ave., Richmond Hill 18, N. Y.*

For more information circle **318** on inquiry card.

FLAT DELAY LINES

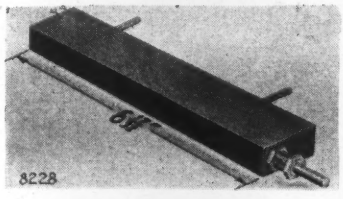
New "Delay-line Flats" with elliptical core make it possible to construct delay lines covering an impedance

range from 75 to 7,500 ohms with delays up to 2 usec using the same compact core (5" x ⅝" x $\frac{3}{16}$"). New "Flats" are characterized by extremely low insertion losses, wide bandwidths, compact size and rugged construction.—*Columbia Technical Corp., 61-02 31st Ave., Woodside 77, N. Y.*

For more information circle **319** on inquiry card.

VARIABLE DELAY LINE

New "Model 403" continuously-variable delay line is designed for use as component or as test equipment in advanced computer and radar systems. Entire delay range, from zero to 0.7-usec maximum delay, is cov-



Waugh

TURBINE FLOWMETERS

for APPLICATIONS in:

MISSILES

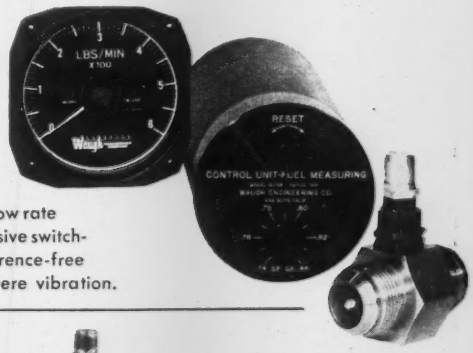
Lightweight aluminum Flow Pickups for flight or ground testing insert in propellant ducts of guided missiles. Flow rates from 20 to 6000 gallons per minute are covered in sizes 4" through 11". Output is suitable for telemetering or ground recording.

LABORATORY

FR series Pulse Rate Converters convert frequency output of any turbine flowmeter into a DC signal. Models include cabinet or relay rack mounting, with outputs for potentiometer recorders or oscillographs. Available features include built-in indicator, and multiple input channels.

AIRCRAFT

New, completely transistorized Airborne Fuel Measuring System with specific gravity adjustment provides direct indication of both fuel flow rate and total fuel consumed. Exclusive switch-type flow pickup gives interference-free operation in conditions of severe vibration.



GENERAL SERVICE

Standard FL series Flow Pickups for use in aircraft, chemical processing, food, and petroleum industries, measure flows from .065 to 400 gallons per minute. Applications include flow rate indication, recording, and control, as well as indication and control of totalized flow.

Waugh ENGINEERING COMPANY
FLUID FLOW MEASURING EQUIPMENT

7842 BURNET AVENUE, VAN NUYS, CALIFORNIA—STanley 3-1055

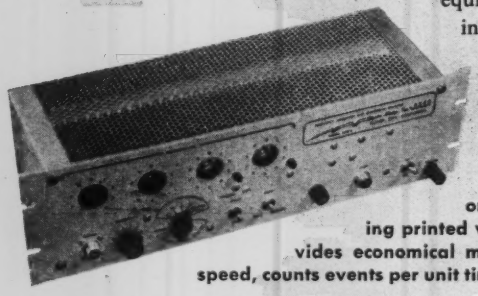
For more information circle **115** on inquiry card.

Electro-Pulse
ELECTRONIC COUNTING EQUIPMENT

ECONOMY, RELIABILITY, COMPACTNESS

- **PRESET COUNTERS**
- **FREQUENCY INDICATORS**
- **TIME INTERVAL METERS**
- **COMBINATION INSTRUMENTS**

Using cold cathode glow transfer tubes for counting and indication, Electro-Pulse counting and measuring equipment features the reliability inherent in simplified circuitry.



MODEL 7340B FREQUENCY INDICATOR AND COUNTER

Available for rack panel or bench mounting and utilizing printed wiring, the Model 7340B provides economical measurement of frequency or speed, counts events per unit time, or operates as a totalizer.

Write for complete data: our Bulletin 7340B/IA

Representatives in Major Cities

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For more information circle **116** on inquiry card.

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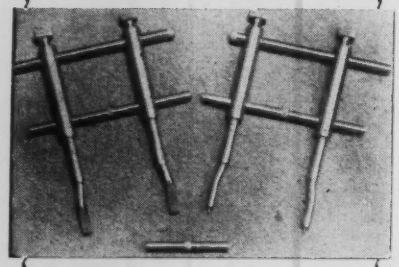

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Pittsburgh 14, Penna.

For more information circle **118** on inquiry card.

NEW INSTRUMENTS

ered by one control shaft in ten turns. Unit can be locked at desired delay by an optionally available lock-nut attachment. Attenuation less than 1 db; resolution better than 0.001 usec; maximum rise time 0.06 usec; impedance 500 ohms.—*ESC Corp., 534 Bergen Blvd., Palisades Park, N. J.*

For more information circle **320** on inquiry card.

ELECTROMECHANICAL COMPONENTS

MAGNETIC CLUTCH

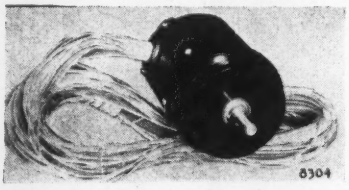
New "Magnetic Type Friction Clutch" for application in low-power servomechanisms meets stringent

military environmental and performance specifications. Standard models operate on 24 vdc and deliver at least 50 oz-in of torque. Response time is within 3 milliseconds.—*Dynamic Instrument Corp., 59 New York Ave., Westbury, L.I., N. Y.*

For more information circle **321** on inquiry card.

SAMPLING COMMUTATOR

New "Type AB High Speed Sampling Switch" provides single pole sampling of 60 contacts at rates up to

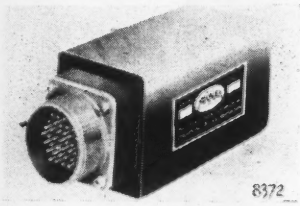


30 rps; requires 3 oz-in torque; provides long life under shock and vibration; has provision for potting all wiring when required.—*Applied Science Corp. of Princeton, P. O. Box 44, Princeton, N. J.*

For more information circle **322** on inquiry card.

SAMPLING COMMUTATOR

New "Type CP-299" comprises a standard motor-driven "Model TM-55 Series Commutation Switch" with "Supramica 555" ceramoplastic commutator plates; has two rings of contacts and a maximum of 32 connector leads, brought out to a standard AN



connector for easy installation. Brush size and type, duty cycle and general configuration are standard, but some modification of circuitry is possible. Noise level is below 50 mv.—*Mycalex Electronics Corp., 125 Clifton Blvd., Clifton, N. J.*

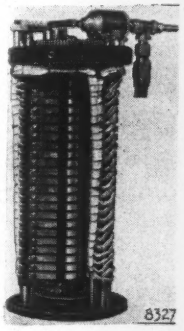
For more information circle **323** on inquiry card.

TEN-POSITION TAP SWITCH

New hermetically-sealed switch features low-loss glass insulation, solid molybdenum contact points, solid coined-silver contact arm, hardened shafts and wear surfaces; is rated 3 amp at 115 v inductive; withstands 5 *G* vibrations from 5 to 2,000 cps; operates up to 350°F; is available in various terminal designs and for various mountings.—*Pacific Div., Farnsworth Electronics Co., 815 San Antonio Rd., Palo Alto, Calif.*

For more information circle **324** on inquiry card.

SLIP-RING ASSEMBLY

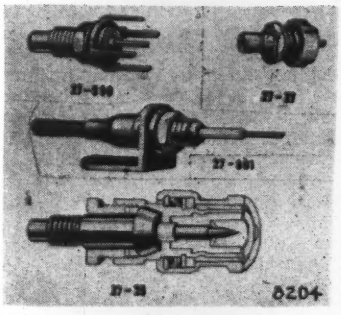


New slip ring assembly of unique construction provides continuously-variable remote control of brush pressure by means of a miniature air cylinder in brush housing. Among advantages: continuous compensation to minimize wear on both brush and ring surfaces to attain minimal noise level; adaptability to applications requiring either high or low brush pressure; extended life at all speeds.—*Electro-Miniatures Corp., 1060 Elm Ave., Ridgefield, N. J.*

For more information circle **325** on inquiry card.

SUBMINIATURE CONNECTORS

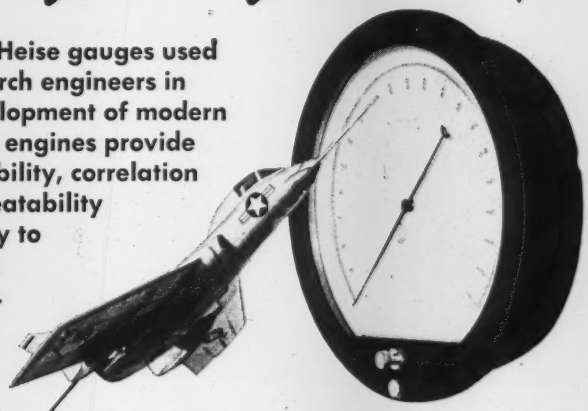
Four new RF connectors make a total of 30 "Subminax" now available: "27-27" hermetic seal panel re-



HEISE GAUGES

Conquest of the Sky

Heise gauges used by research engineers in the development of modern turbo-jet engines provide the reliability, correlation and repeatability necessary to scientific progress.



Actual operating conditions are reproduced in the Cox Test Stand built by Commercial Research Laboratories to test for optimum efficiency of jet fuel nozzles.

The six Heise gauges incorporated in the test stand feature in the vital and exacting performance which this instrument must accomplish.

Higher air speeds, rates of climb and economic fuel consumption, factors which every day reach and surpass new levels of efficiency, are made possible by the continuing efforts of research men equipped with today's most accurate instruments.

Pressure Ranges 15 to 20,000 P.S.I. Dial Sizes 8½"-12"-16"

Prices from $151.60.

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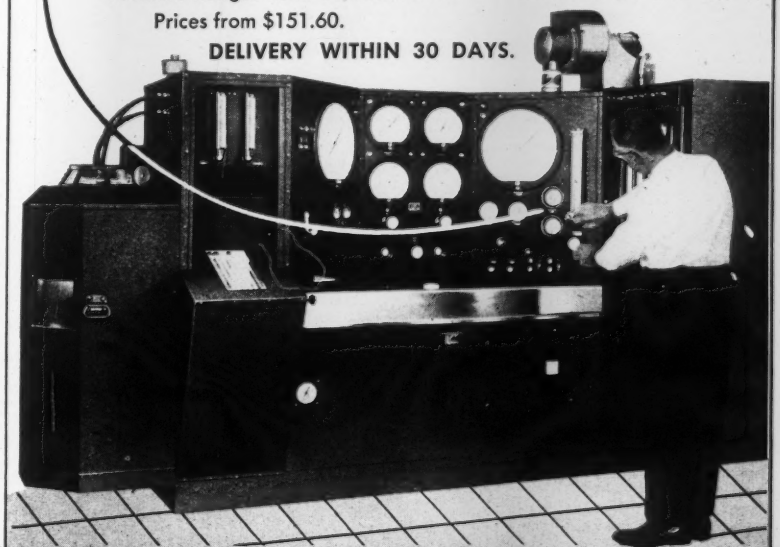

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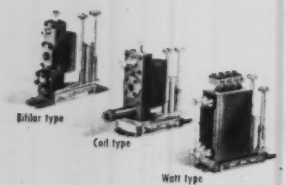
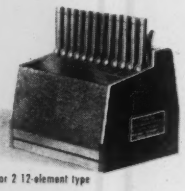
for recording short, high-speed transients

SYNCHRONOUS TIME-LINE MARKER
for 10, 1, 1/10 and 1/100 sec



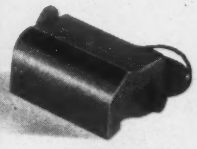
1 to 6 channels



1 or 2 12-element type

6 to 24 channels

GALVANOMETERS



ROTATING-MIRROR VIEWING ATTACHMENT
for viewing wave shapes

The HATHAWAY S14-E OSCILLOGRAPH

is a high quality oscillograph available with a wide assortment of standard accessories and galvanometers. This flexibility makes it adaptable to your various recording problems. Research laboratories and mobile units in industry and universities reduce their instrument investment and rely on the easy-to-operate, versatile Hathaway S14-E Oscillograph.

Write for Bulletin 1-4H describing features of the Hathaway S14-E.

ADDITIONAL SPECIFICATIONS

OPTICAL SYSTEM—Individually controlled galvanometer trace width.
AUTOMATIC LAMP BRILLIANCE CONTROL—Insures clear records.
CHART DRIVE SYSTEM—Quick-change transmission; range of 9 speeds easily selected; 1/10 to 600 in./sec.
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			Midwest 4-9004		

For more information circle **87** on inquiry card.

ceptacle, "27-28" between-series adapter; "27-800" printed circuit receptacle and "27-801" cable termination. All have 50-ohm impedance and are gold-plated.—*American Phenolic Corp., Chicago* 50, *Ill.*

For more information circle **326** on inquiry card.

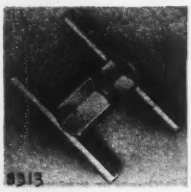
MECHANICAL COMPONENTS

SHAFT COUPLINGS

New "Oldham Couplings," for control and computer equipment, compensate for shaft parallel misalignment (0.03" max), or for expansion; permit components to be removed from equipment without removing shafts. Five models, to take $\frac{3}{16}$", ¼" and $\frac{5}{16}$" shafts; and $\frac{3}{16}$-¼" and ¼-$\frac{5}{16}$" shaft combinations.—*Component Sales, Ford Instrument Co., Div. of Sperry Rand Corp., 31-10 Thomson Ave., Long Island City* 1, *N. Y.*

For more information circle **327** on inquiry card.

LEAK TEST FITTINGS

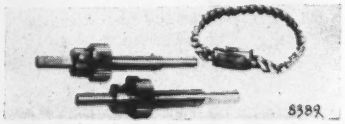


New "Sealastic" fitting, especially for leak-testing fabricated tubing on all types of equipment, features easy finger tightening and disconnecting; facilitates charging, flushing and evacuation; is available from stock in standard sizes from $\frac{3}{16}$" to ½".—*Chicago Forging & Manufacturing Co.,* 2000 *Southport Ave., Chicago* 14, *Ill.*

For more information circle **328** on inquiry card.

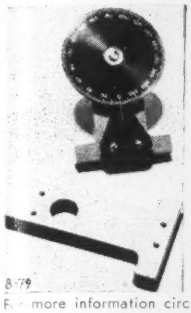
CLUTCHES

New clutches disengage a particular subassembly from entire system, either to render that portion inoperative when it is no longer required or to protect it from strains of overload on motors and gear strains. Separation can be effected either when a predetermined torque has been reached or at a particular stage in sequence of operation. Three different models: (1) Friction Clutch unit provides clutch action only at a predetermined torque; can be set to slip at any torque from 2 oz-in to 20 oz-in; (2) Single Drive Magnetic Clutch Output torque 40 oz-in; (3) versatile Reversing Magnetic Clutch usable either as a reversing clutch or as a two-speed drive; output torque 40 oz-in.—*Servo Corporation of America,* 20-20 *Jericho Turnpike, New Hyde Park, L. I., N. Y.*



For more information circle **329** on inquiry card.

DIAL & INDEX HANGERS



New "Type AN" hangers are universal in design; can be used with disc or drum dials; are available from stock in three shaft sizes ⅛", 3/16", or ¼". —*PIC Design Corp., P.O. Box C, East Rockaway, L. I., N. Y.*

For more information circle **330** on inquiry card.

FLARELESS TUBE FITTING

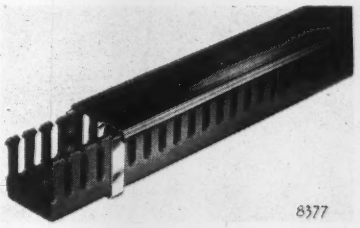
New "Hi-Seal" makes a foolproof, butt-tight joint. Shoulder on sleeve prevents incorrect assembly even by

inexperienced personnel. Three serrated edges on sleeve bite radially into tube surface to a controlled depth, making a triple seal. Fitting remains pressure-tight beyond burst strength of tube itself; conforms to JIC Hydraulic Standards and ASME Code for pressure piping; various types and shapes, in sizes for ⅛" to 1½" OD tubing; with long "Dryseal" pipe threads, or with straight threads with O-ring seal.—*Imperial Brass Mfg. Co., Dept. HSF, 1200 Harrison St., Chicago 7, Ill.*

For more information circle **331** on inquiry card.

SNAP-ON DUCT FASTENER

New cadmium-plated U-shaped spring clip simplifies installation of complicated control panel wiring; is

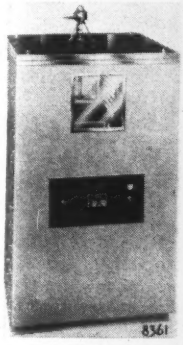


external; does not require mounting holes in duct or cover. It fastens to control panel with a self-tapping screw: duct snaps into clip, wiring snaps into duct slots, and cover snaps onto duct.—*Panduit Co., Dept. IAP, 10132 S. Washtenaw, Chicago, Ill.*

For more information circle **332** on inquiry card.

LABORATORY INSTRUMENTS & EQUIPMENT

LOW-TEMP VISCOSIMETER



New "Cat. #4550" mechanically-refrigerated self-contained viscosity bath eliminates usual use of dry ice and acetone mixtures, gives uninterrupted service by utilizing mechanical refrigeration. Temperature range from 0 to −65°F; adjustable hydraulic thermostat; 1-hp compressor hermetically sealed; uniform temperature assured by an explosion-proof air-driven stirrer.—*Labline, Inc., 3070-82 W. Grand Ave., Chicago 22, Ill.*

For more information circle **333** on inquiry card.

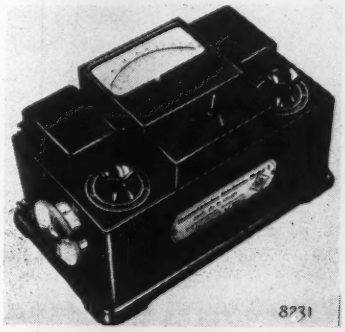
MVT TESTING ACCESSORIES

New accessories for cup method of General Foods Moisture Vapor Transmission test procedure: (1) dish holder for size #6 cup which is too large for standard lab balance; (2) brass template for pouring wax with no lugs attached; (3) aluminum test dishes; (4) dish and cover inverted to show snug fit; (5) aluminum template; (6) special depth dishes; (7) brass template for pouring wax, with adjustable lugs; (8) dishes with various degree of open-flanged rims for more thorough cleaning.—*Atmosphere Control Co., Inc., 5315 Chester Ave., Philadelphia 43, Pa.*

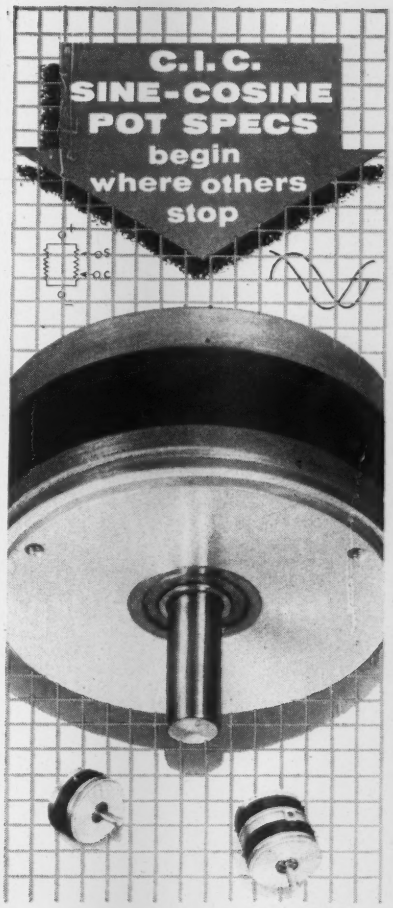
For more information circle **334** on inquiry card.

PHOTOELECTRIC COLORIMETER

New "Model VI Universal Colorimeter" (made by Dr. B. Lange, Berlin) is suitable for all colorimetric meas-



C.I.C. SINE-COSINE POT SPECS begin where others stop



Infinite resolution and absolute dependability distinguish CIC ultra-precise Potentiometers. In the generation of the sine wave CIC Pots provide smooth, reliable performance, distortion free at all angles of rotation.

CIC carbon film Sine-Cosine Pots, the proven product of a unique research program, provide greater accuracy in smaller case sizes. Sizes range from 1" to 5" diameter with corresponding best conformities from .3% to .03%. Compensation for loading can be provided with **no loss of performance.**

At speeds in excess of 1,000 r.p.m. CIC guarantees life in excess of two million revolutions.

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Our highly qualified engineers are ready to discuss your specific requirements with you. Call us today.

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Detailed Technical Data Sheets available on request.

CIC COMPUTER INSTRUMENTS CORPORATION

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For more information circle **121** on inquiry card.

Who Gets the Order—and Why?

If you're the person responsible for buying your company's springs you *know* why. You know the price should be right . . . equal or better. But you know that price isn't the final factor either. You've found that dependability of the supplier is of greater importance. His delivery commitment . . . his assured uniformity of quality products . . . and his engineering and manufacturing organization that can help solve unusual problems that so often save time and final costs. It's these things that spring buyers keep in mind when the supplier's name is put on the order.

Lewis' name goes on the "P.O.'s" of so many large companies for one or maybe all of the reasons mentioned above. We're proud of that—and we are certainly going to make sure that all of our present and future spring buyers have the same important reasons to put "Lewis" on the order—and more too, if we can find them. How can we help you?

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Lewis PRECISION SPRINGS

The finest light springs and wireforms of every type and material

For more information circle **122** on inquiry card.

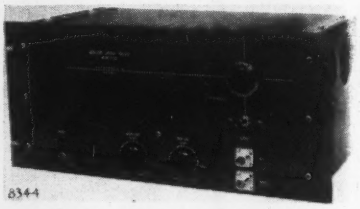
NEW INSTRUMENTS

urements including turbidity and fluorescent and photoelectric titration; permits making 100% objective measurements by direct reading even in fully-illuminated rooms; has connection for a recording instrument. Several acid-proof cuvettes for 0.1 to 100 cc and many test tubes for 1 to 20 cc are available.—*Epic Inc.*, 154 *Nassau St., New York* 38, *N. Y.*

For more information circle **335** on inquiry card.

MERCURY SWITCH PULSER

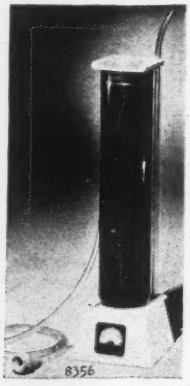
New "N-101," for calibration and stability measurements involving scintillation spectrometry circuits, fea-



tures continuously-adjustable rise time (0.03-0.5 usec); output up to 10 ma (max 22 v) either polarity; is continuously-variable with better than 0.1% linearity.—*Hamner Electronics Co., Inc., Princeton, N. J.*

For more information circle **336** on inquiry card.

DEMINERALIZER



New "No. DI-50 Water Master Table Model Demineralizer" features direct faucet connection for "De-Ionized Water on Tap" (ionically equivalent to distilled) with flow rates of better than 1 gpm. Direct-reading indicator is calibrated in ohms/cc and parts per million. Dimensions 20" high on a 6½" square base.—*Ion Exchange Products*, 9349 *S. Cottage Grove, Chicago* 19, *Ill.*

For more information circle **337** on inquiry card.

MISCELLANEOUS

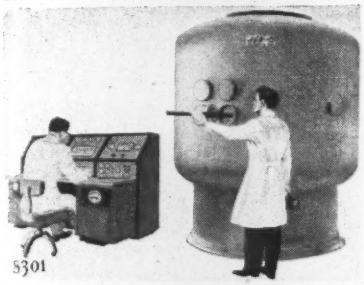
2-STATION INTERCOM KIT

New "Knight-Kit" consists of a Master station, Remote station, and 50-ft cable. Master unit has one-knob volume control and on-off switch. Remote station includes a press-to-talk switch. Remote switch can be left in the "talk" position to permit continuous listening in by Master station. Master can communicate with Remote regardless of position of switch on latter. Only Master need be connected to a power source.—*Allied Radio Corp., Dept. PR-787, 100 N. Western Ave., Chicago* 80, *Ill.*

For more information circle **338** on inquiry card.

"MASS-PRODUCED" REACTOR

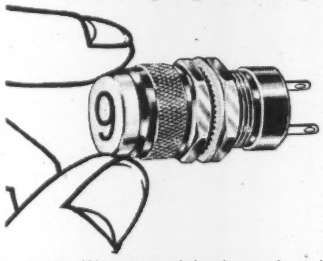
New "AGN 201" is a transportable reactor of sufficient size and safety to allow it to be placed into an ordinary room of an ordinary building. Self-contained feature obviates need of costly shielding. Unique quadruply-sealed solid core (using about 600 g of U^{235} of 20% enrichment embedded in radiation-stabilized polyethylene) seals-in fission products: no waste disposal problem and no escape of radioactive contaminants. Every effort has been exerted to make "AGN 201" the safest reactor available. Complete versatility includes possibilities for on-stream analysis and process control.—*Aerojet-General Nucleonics, San Ramon, Calif.*



For more information circle **339** on inquiry card.

PILOT LIGHT

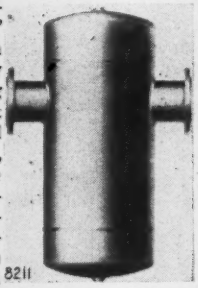
New "Series 134-3830-375" subminiature pilot lights with rotatable lenses feature spring mounting of lens to facilitate positioning after installation of unit. Wide choice of lens colors; soldering terminals or taper-tab quick-connect terminals; mounting from back or from front of panel.—*Dialight Corp., 60 Stewart Avenue, Brooklyn 37, N. Y.*



For more information circle **340** on inquiry card.

AIR AND STEAM CLEANER

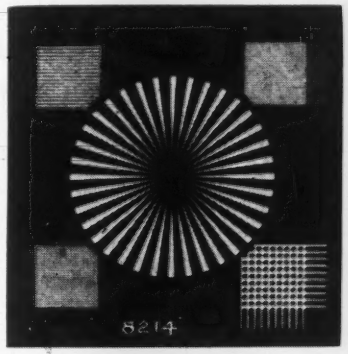
New "Bradshaw Cleaner," said to approach 100% efficiency in removing moisture and dirt from steam and compressed air, is a multi-stage device comprising many stainless steel separating units in series, each with extremely high efficiency. Three standard types for line diameters up to 12"; larger sizes special.—*Bradshaw & Co., 311 Ross St., Pittsburgh 19, Pa.*



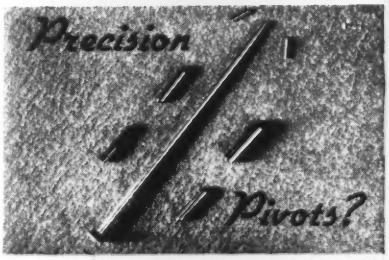
For more information circle **341** on inquiry card.

RETICLE PROCESS

Newly available in U.S. is "Diadur" reticle process developed by Johannes Heidenhain in Germany. It is a photoetching process which makes use of a photographic durable dye image. It can be applied over an evaporated metal film deposited on glass under high vacuum. Illustration shows an enlargement of a reticle one millimeter square. In finest cross-hatching, quadrant can be as small as 5 microns square. Markings can be opaque on a clear base, or clear on an opaque base.—*Bushnell Optical Enterprises, 273 Bushnell Bldg., Pasadena, Calif.*



For more information circle **342** on inquiry card.



The "spike" in the center is a common pin. The others are VK precision pivots.

Call VK

Steel, chromium plated, or carbide precision pivots to .013" diameter. 1 RMS or finer surface finish. Diameter tolerance to .000010". Chamfers, radii, lapped ends, etc.

Also volume production lapping of flat or round production parts.

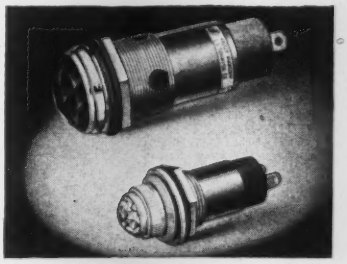
Send us your specifications.

The **VAN KEUREN COMPANY**
176-A WALTHAM ST. WATERTOWN, MASS.

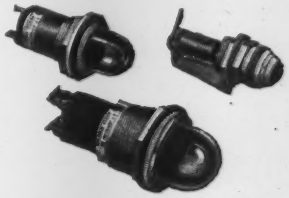
For more information circle **166** on inquiry card.

NOW!
QUICK-EASY SELECTION

Johnson PILOT LIGHTS



For "in the field" replacement or original equipment manufacture, you'll find that it's easier and faster to specify Johnson Panel Indicators. Available in a wide variety of types, Johnson "preferred" units are immediately available at parts distributors throughout the country. Careful standardization, with an eye to replacement as well as interchangeability, makes Johnson Pilot Lights the first choice of many leading manufacturers.



Available types include: continuous indication neon types; models for high and low voltage incandescent bulbs; standard or wide angle glass and lucite jewels in clear, red, green, amber, blue, or opal lenses. Specials, including those meeting military specifications are also available in production quantities. For full information write today!

NEW CATALOG! Covers complete Pilot Light Line—write for your copy today!

SOLDERLESS NYLON CONNECTORS

Available in 11 bright colors. Shockproof nylon sleeves won't chip or crack with hardest usage. Excellent for high voltage applications. Highly resistant to extremes of heat, cold, and moisture. Tip and banana plugs designed for simplified solderless connection of up to 16 gauge stranded wire — jacks require soldered connection. Simple, functional design gives top quality at low cost.

Write for samples, prices, and further information.

E. F. Johnson Company
2714 Second Ave. S.W. • Waseca, Minn.

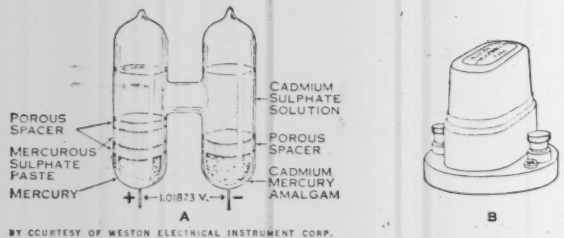
For more information circle **123** on inquiry card.

INSTRUMENTS and AUTOMATION Briefs

For this literature circle number on inquiry card.

Electrical Measuring Instruments

In 1892 Edward Weston developed the standard cell, with electrodes of cadmium amalgam and mercury in a cadmium sulphate solution. This combination had a low temperature coefficient and a long life.



BY COURTESY OF WESTON ELECTRICAL INSTRUMENT CORP.

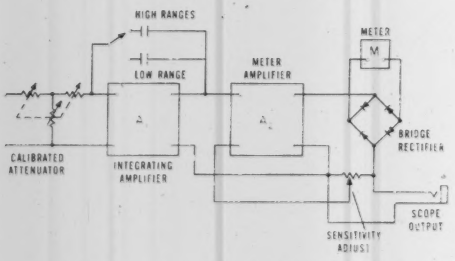
The Weston cell is made in two forms. The normal cell is made with a saturated solution of cadmium sulphate with an excess of cadmium sulphate crystals placed above the porous spacer in both limbs. Assembled with materials of a high degree of purity, such a cell has an open circuit potential of 1.01863 absolute volts at 20°C.

The other form, the Weston standard cell has the same electrodes but the solution is made saturated at 4°C, above which point the solution becomes unsaturated . . . the temperature coefficient is much smaller . . . (*From new 20-page Technical Monograph TM-101, covering all basic electrical movements, Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.*)

For this literature circle **401** on inquiry card.

Vibration Meter

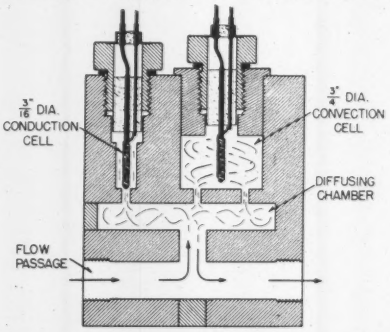
The Type 1-128 Vibration Meter circuit is basically a constant-impedance resistive attenuator, followed by an all-transistor two-stage integrating amplifier. This integrated signal is further amplified and applied to the bridge detector. Each amplifier stage employs two junction transistors stablized by feedback. Displacement readings are indicated on the 500-microampere meter, which is calibrated in tenths to read from zero to five mils on the XI range . . . (*From new 4-page Bulletin 1566, Consolidated Electrodynamics Corp., 300 North Sierra Madre Villa, Pasadena, Calif.*)



For this literature circle **402** on inquiry card.

Industrial Gas Analyzer

Conventional analyzers using the Thermal Conductivity principle rely on the fact that rate of heat loss from a heated filament in a chamber is proportional to the thermal conductivity coefficient of the gas contained . . .

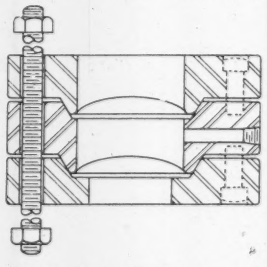


In the M-S-A Gas Thermatron the thermal convection of the gas mixture is used as well as the thermal conductivity effects which occur in the cell to provide an accurate analysis of one component in a multicomponent gas mixture . . . The difference between the rate of heat loss in a large cell and that in a small cell becomes greater as the thermal conductivity of the gas decreases. This effect is usually referred to as gaseous "convection" in thermal conductivity cells, the effect of which is known to increase not only with the molecular weight of the gas but also as the diameter of the cell increased. (*From new 4-page Bulletin No. 0716-1, Mine Safety Appliances Co., 201 N. Braddock Ave., Pittsburgh 9, Pa.*)

For this literature circle **403** on inquiry card.

Rupture Discs

Model D rupture discs are composed of two matched, prebulged discs which are assembled as a unit for installation in a BS&B Safety Head. The upper disc is slotted and the lower disc, similar to a conventional disc, provides the pressure seal. Both upper and lower discs determine the rupture pressure and are available in a large selection of disc materials. This model has no vacuum support and consequently can only be used on systems operating under continuous positive pressure . . . (*From new 4-page Catalog 77-31, Black, Sivalls & Bryson, Inc., Kansas City, Mo.*)



For this literature circle **404** on inquiry card.

Alumalife® Case

Phenol Case

Why do ASHCROFT DURAGAUGE CASES increase service life?

Duragauge casings add extra-long service life to Duragauges because they're available in three different materials: you can choose the case-material that stands up best in *your application.* You have a choice of *Alumalife®* – a special aluminum alloy; *Cast Iron*, rugged and durable; and *Phenol*, a tough, rigid plastic.

Duragauge casings are dust and moistureproof. Chrome-plated, die-cast retaining rings keep the dial cover glass tightly in position and prevent the entrance of dirt or harmful fumes. Depending upon material, casings are Bonderized and the ring is Anodized and dichromate sealed for protection from corrosion.

For added protection, there is the Maxisafe Duragauge casing with a solid front – a special design for maximum safety and ease of maintenance. Duragauges are easy to service since Duragauge casings are constructed so that the entire system – socket, tube, tip, movement, dial and pointer – can easily be removed as a unit.

Lifetime Duragauge cases are available for numerous dial sizes. You have a choice of Bourdon tube materials, a wide range of pressures, and a movement made completely of stainless steel or stainless steel with nylon bearings and pinion gear.

Whatever case material and gauge system is best for your needs, you can rely on the Ashcroft Duragauge for highest sustained accuracy and long service life.

FOR PROMPT ASSISTANCE in selecting the right Ashcroft Duragauges for your specific needs, depend on the experience of your Industrial Supply Distributor. He is as close as your telephone.

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ASHCROFT GAUGES

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MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Okla.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

G4-56

For more information circle **124** on inquiry card.

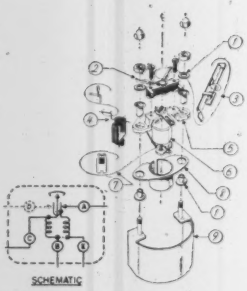
VHS* RELAY

(*Very High Sensitivity)

● The VHS is a balanced armature, Alnico magnet type relay. It is internally shock-mounted and resistant to vibration. The screw-on cover is gasket sealed. It can be opened and resealed.
Connections: 9 pin octal style. Dimensions: 1¾ diameter x 2¼ long. Weight: 4 ounces.
Sensitivity: Infinite variations from 0.2 Ua. to 10 Amp. or 0.1 Mv. to 500 volts, self contained. Higher volts or amps with external multipliers. A.C. rectifier types. Trip point accuracies to 1%. Differential 1%. The degree of resistance to shock and vibration primarily depends upon sensitivity and type of action wanted. In general, the relays will not be permanently damaged by shocks of 100 G's and vibrations up to 2,000 cps at 3-4 G's. The most sensitive relays may close their contacts under these conditions.
Contacts: SPST or SPDT, 5-25 Ma. D.C. Other ratings to ½ Amp. A.C. A locking coil gives high pressure and chatter free contact even under shock and vibration.
Prices on the order of $20-$80. Delivery 4 to 6 weeks. Assembly Products, Inc., Chesterland 10, Ohio. (West Coast: Desert Hot Springs 10, Calif.)

Model 266

Sample specs. are: 0.2 micro-amperes, (12,000 ohms coil) or, 0.1 millivolts, (5 ohms.)



SCHEMATIC

1. Shock mount
2. Contact assemby
3. Contact detail
4. Armature with contact detail
5. Cast bracket
6. Alnico magnet
7. Bearing detail
8. Yoke (steel)
9. Mounting frame

For more information circle **125** on inquiry card.

new SCHERR TOOLMAKERS MICROSCOPE

WITH INTERCHANGEABLE DIAL TEMPLETS AND OCULARS

57
58
59
Reading Angles in Minutes
Thread Templets for U. S. National Thread Profiles- 6-80 Pitch. Radii Templets, etc.
LARGE MICROMETER DRUMS READ DIRECTLY IN .0001"
Measuring Range 2" x 1-1/2" and other sizes
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COMPLETE LINE OF PRECISION INSTRUMENTS

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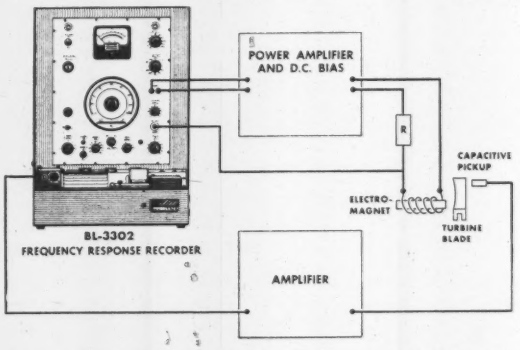
For more information circle **126** on inquiry card.

BRIEFS—CONTINUED

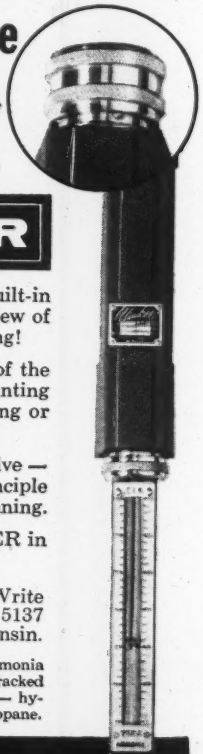
Resonance Recorder

Mechanical resonances may be sensed by strain gauges, vibration pickups, and other media appropriate to the test and plotted as amplitude variations versus excitation frequency by the Level Recorder . . . This application



may be readily illustrated by the environmental test to determine the natural mechanical resonances of either a gas or steam turbine blade. The test set shows the Signal Generator Model BL-1014 driving an electromagnet. The turbine blade mounted in the alternating magnetic field is excited into vibration. To assure minimum fluctuation in excitation versus frequency the electromagnet is driven with constant current. This is accomplished by the use of a series resistor as shown to provide a feedback voltage which when applied to the BL-1014 compressor circuit will regulate the oscillator output to maintain constant driving current. A d-c bias is used to avoid frequency doubling

the meter with the built-in Valve...



Waukee

FLO·METER

With the Waukee FLO-METER'S built-in Valve, you adjust the gas flow in full view of the scale. You can see what you're doing!

The Control Valve is an integral part of the FLO-METER, designed for panel mounting and simple piping. No extra valve piping or installation. Saves time and money.

It's a Waukee-designed and built valve — sturdy, simple, smooth. Needle-valve principle for accuracy, sensitivity, and easy cleaning.

And you can still clean the FLO-METER in 5 minutes *or less!*

Complete information in Bulletin 203. Write for it. **Waukee Engineering Company**, 5137 North 35th Street, Milwaukee 9, Wisconsin.

For measuring: air — ammonia — dissociated ammonia — argon — butane — city gas — endothermic cracked — exothermic cracked — forming gas — helium — hydrogen — natural gas — nitrogen — oxygen — propane.

Waukee FLO-METERS • AIR-GAS MIXORS
INDUSTRIAL WASHING MACHINES

For more information circle **127** on inquiry card.

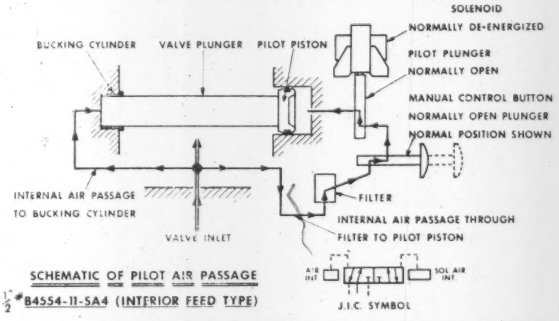
and undesirable harmonics.

The vibration resonances and nodal patterns may be sensed by either a capacitive type pickup or a modified phonograph pickup for minimum damping. (*From new 8-page Catalog ED11503, Brush Electronics Co.*, 3405 *Perkins Ave., Cleveland* 14, *Ohio.*)

For this literature circle **405** on inquiry card.

Air and Hydraulic Control Valves

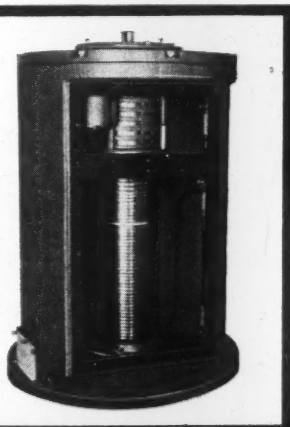
Pilot air is taken from the valve inlet, through a built-in filter, and a normally open manual control plunger, which is in series with a normally open pilot plunger.



SCHEMATIC OF PILOT AIR PASSAGE
½" #B4554-11-SA4 (INTERIOR FEED TYPE)

In the normal position, with the solenoid de-energized, the force of the pilot piston overcomes the bucking cylinder resistance, and holds the valve plunger to the left. Energizing the solenoid exhausts the air from the pilot piston, and the bucking cylinder shifts valve plunger to the right . . . (*From new 6-page Bulletin No.* 561, *C. B. Hunt & Son, Inc., Salem, Ohio*).

For this literature circle **406** on inquiry card.



COMPLETE SLIP RING ASSEMBLY

This special division of D. E. Makepeace is completely staffed with engineering specialists to design and manufacture all types of slip rings and rotating electro-mechanical equipment, for your particular requirements.

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SLIP RINGS

ADVANCED STAMPED SLIP RING DESIGN

We will design or manufacture to your requirements.

D. E. MAKEPEACE COMPANY
Division of Union Plate and Wire Co.
Attleboro, Mass.

Prime source for Slip Ring Assemblies, Brush Block Assemblies, Specialized Wave Guide and Tubing, Collector Rings and Brushes.

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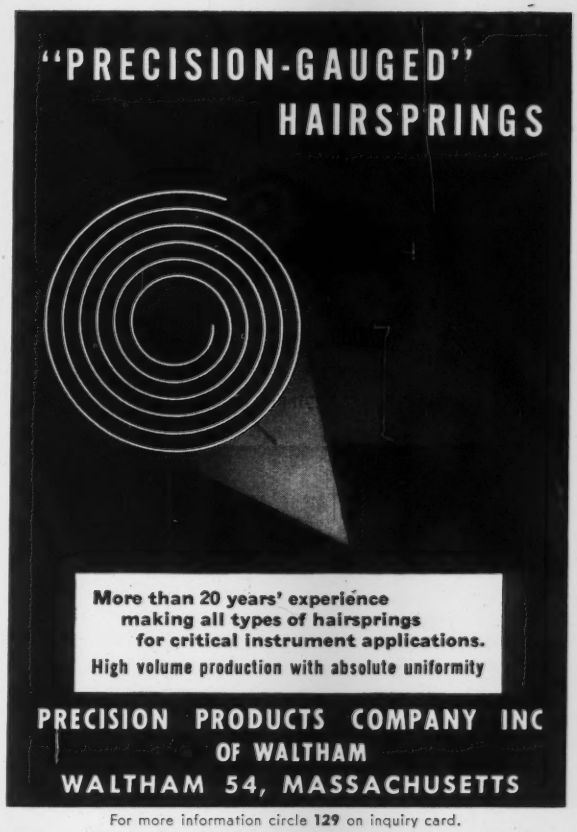
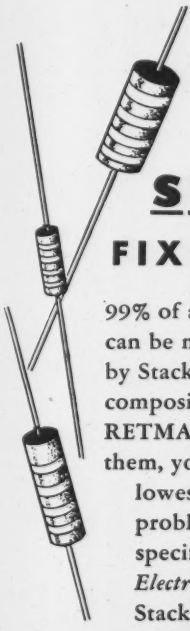

"PRECISION-GAUGED"
HAIRSPRINGS
More than 20 years' experience making all types of hairsprings for critical instrument applications.
High volume production with absolute uniformity
PRECISION PRODUCTS COMPANY INC
OF WALTHAM
WALTHAM 54, MASSACHUSETTS

For more information circle **129** on inquiry card.



IT PAYS TO SPECIFY **STANDARD** FIXED RESISTORS

99% of all modern circuit requirements can be met fastest and most economically by Stackpole ½, 1 and 2-watt fixed composition resistors in the standard, RETMA preferred values. By specifying them, you are assured of fast deliveries, lowest prices and fewer stocking problems. Write for handy wall chart specifying these standard values:
Electronic Components Division
Stackpole Carbon Co., St. Marys, Pa.

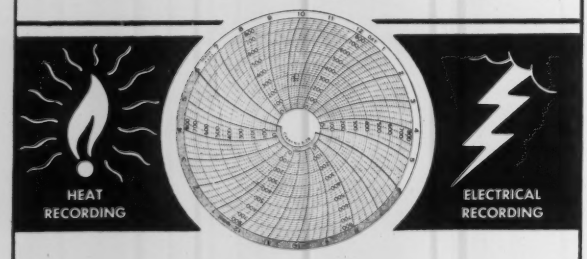
STACKPOLE

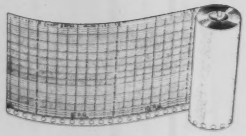
FIXED & VARIABLE RESISTORS • SLIDE SWITCHES • IRON CORES
CERAMAG® FERROMAGNETIC CORES • MOLDED COIL FORMS
'GA' LOW-VALUE CAPACITORS • CERATAB® PRINTED CIRCUITS

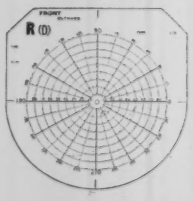
For more information circle **130** on inquiry card.

For more information circle **131** on inquiry card.

CHARTS of all types







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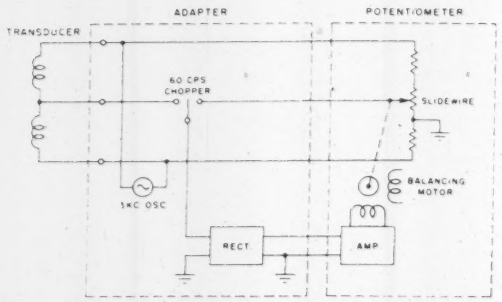
GUBELMAN PUBLISHING COMPANY
100-106 EAST KINNEY ST. NEWARK 5, N. J.

BRIEFS—CONTINUED

Pace Model P1 Pressure Transducer

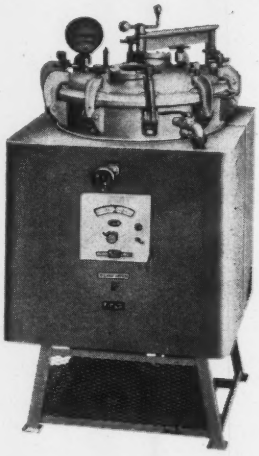
Differential or gage pressure measurement can be made with a precision of ±1% full scale using the magnetic reluctance type Pace Model P-1 Pressure Transducer. The



basic transducer consists of a diaphragm magnetically coupled to a balanced inductive pick-off system which delivers a full scale output of 40 millivolts per volt in AC bridge circuit operation. The absence of mechanical coupling between the diaphragm and the pickoffs, which are embedded in the rigid body, gives an extremely high natural frequency and freedom from spurious resonances, important in dynamic pressure measurement . . . (*From new 2-page bulletin, Pace Engineering Company, 6914 Beck Ave., North Hollywood, Calif*)

For this literature circle **407** on inquiry card.

AUTOMATIZE YOUR ENCAPSULATING



RED POINT Encapsulating machines are fully automatic in operation. They produce embedded or potted assemblies under vacuum.

Simple operation and consistent results are features of the RED POINT Encapsulating and Casting Machines. Autoclaves of the units will hold pressures to 110 psi, while the vacuum system pumps down to 100 microns absolute pressure. Swing-away lid with observation window allows the operator to check work in progress.

Temperature range of heated units is ambient to 400° F. and standard casting cup capacity is 194 cc, or 6.56 fluid oz. Either 8 or 22 casting cups are contained in a single unit.

Write, wire or telephone for further information.

RED POINT CORPORATION
1907 Riverside Drive, Glendale 1, Calif.
Telephone—THornwall 2-4895

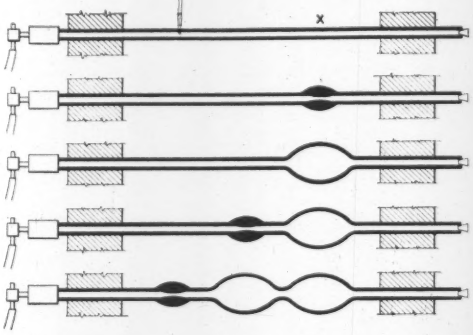
PIONEERS IN HIGH VACUUM IMPREGNATING EQUIPMENT FOR THE ELECTRONIC INDUSTRY.

For more information circle **132** on inquiry card.

Glass Blowing on the Glass Lathe

Some condensers require bulbs instead of straight tubing. To make these bulbs by hand requires great dexterity. On the lathe the technique is simple and rapid.

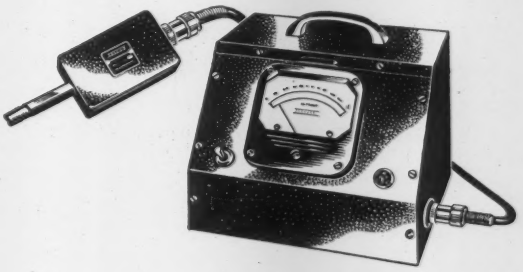
Chuck a 12mm x 30 inch tubing, one end in each stock, allowing about 10" between chucks. On the tailstock side



let tubing protrude, and plug this end. With Polymix Torch heat at point X (Fig. 10). As glass becomes orangey-red, push tailstock in to thicken wall. Make three or four bulbs; loosen headstock chuck and move tailstock to right to give new working area; continue with your series . . . The Polymix Torch is recommended for this operation over other gas-oxy burners since the flame has the necessary softness and density and is wide enough to cover needed area. (*From new 32-page booklet "Glass Blowing on the Glass Lathe," Bethlehem Apparatus Co., Inc., Hellertown, Pa.*)

For this literature circle **408** on inquiry card.

STABLE CALIBRATION IN HIGH VACUUM MEASUREMENT



MODEL II TELEVAC

The Model II Televac Thermocouple Gauge provides all the features required in a vacuum-measuring instrument:

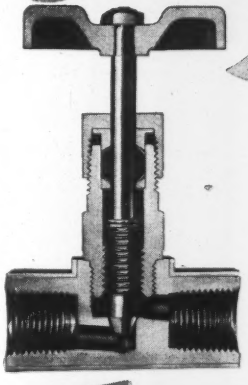
- Stable Calibration
- Dependable Readings
- Simplified Operation
- Low Maintenance Cost
- Range from 1 to 1,000 μ

WRITE

George E. Fredericks Co.
BETHAYRES • PENNSYLVANIA

For more information circle **134** on inquiry card.

Now...the Marsh Needle Valve in 416 Stainless Steel throughout!



All the superior dependability of the Marsh Needle Valve . . . with all the corrosion resistance and durability of 416 Stainless Steel! Guaranteed for working pressure up to 10,000 psi; equally efficient at any lower pressure. Globe and angle patterns with double female connections in ⅛" to 1" size range. Also globe and angle valves with male inlet, female outlet, ¼" and ½" sizes.

For complete details, write for Bulletin No. NV-2.

MARSH INSTRUMENT CO.
Sales Affiliate of Jas. P. Marsh Corp.
Dept. 42, Skokie, Illinois

MARSH
"THE STANDARD OF ACCURACY"

Marsh Instrument & Valve Co. (Can.) Ltd., 8407 103rd St., Edmonton, Alta., Can.

For more information circle **133** on inquiry card.

get this free illustrated bulletin

How you Can Save Time Measuring Surface Temperatures in Your Plant with

ALNOR PYROCONS

The Alnor Pyrocon combines laboratory precision with production tool ruggedness to give you fast, accurate answers to *all* surface temperature problems. It takes just 3 seconds to give you the temperature of any surface . . . regardless of shape or material . . . revolving or stationary. And the heavy, shock-resisting movement is housed in a balanced unit that's compact, easy to handle.

Mail this ad with your business letterhead to Illinois Testing Laboratories, Inc., Room 518, 420 N. LaSalle St., Chicago 10, Ill.

Alnor

PRECISION INSTRUMENTS FOR EVERY INDUSTRY

For more information circle **135** on inquiry card.

A. D. JONES OPTICAL WORKS

2400 MASSACHUSETTS AVENUE
CAMBRIDGE 40 MASSACHUSETTS
TRowbridge 6-3368 — 3369

A LIST OF MATERIALS WE FABRICATE USED IN OPTICS AND ELECTRONICS

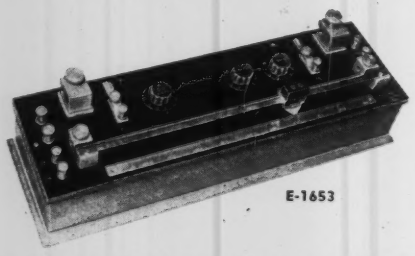
SAWING GRINDING POLISHING DRILLING

ALUM
ALUMINA
ALUMINUM
ANTHRACENE
ARSENIC TRISULPHIDE
BARIUM TITINATE
BISMUTH
BRASS
CARBORUNDUM
CERAMIC
COPPER
*CORNING 707
*CORNING 7052
FERRITE
FERROX
**FLUORIDE, CALCIUM
**FLUORIDE, LITHIUM
GERMANIUM
INDIUM ANTIMONITE
INDOX
MELAMINE FIBER GLASS
MICA, SYNTHETIC
POTASSIUM BROMIDE
*PYREX
*QUARTZ, CRYSTAL
*QUARTZ, FUSED
**SAPPHIRE
**SODIUM CHLORIDE
**STEEL
STRONTIUM TITINATE
TITANIUM DIOXIDE
*VYCOR
*X-RAY LEAD GLASS
ALL TYPES KNOWN GLASS

*Carried in stock
**Purchased for orders

For more information circle **136** on inquiry card.

ACCURATE MEASUREMENT OF LOW RESISTANCE



A LABORATORY TYPE KELVIN BRIDGE RANGE FROM .5 MICRO-OHM TO 1.1 OHMS

Variable standard .01 ohm with 10 x .01Ω extension resistors. 15 inch, 200 division scale accurate to .2 division.

Ratio resistors accurate to .025%.

Other laboratory and portable models, also Wheatstone, Anthony & Mueller Bridges.

SEND FOR OUR BULLETIN E-17

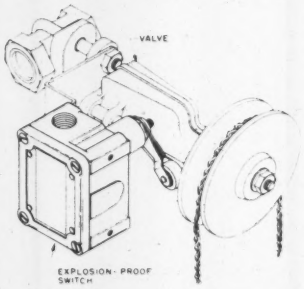
GRAY INSTRUMENT COMPANY
PHILADELPHIA 44, PA.

For more information circle **137** on inquiry card.

BRIEFS—CONTINUED

Explosion-Proof Switch

This explosion-proof switch notifies the operator of the position of the disc in a remotely located valve. The valve, which contains a flammable liquid, is controlled from the



floor below by means of a chain operated wheel. The switch was installed adjacent to the valve so the roller-arm actuator is operated by the rim of the chainwheel. The switch is wired to a set of panel lights which indicate the disc position of the valve. (*From new 16-page Booklet "Micro Tips Digest," Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.*)

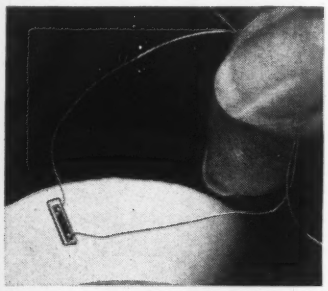
For this literature circle **409** on inquiry card.

Plasticon Capacitors

Type AO: *Resistance* is greater than 10,000 megohms per mfd or 10,000 megohms whichever is lesser, measured at 20°C with 500 VDC applied.

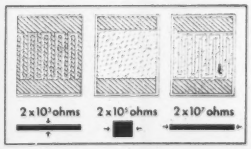
Power Factor—60 cycles. Approx. 0.9% at 20°C; approx. 0.5% at 85°C.

Kodak Ektron Detector...



A unique lead sulfide photosensitive resistor with the following characteristics:

- Response extends from 0.25 microns to 3.5 microns with maximum sensitivity at 2.2 microns in the infrared
- High signal-to-noise ratio in infrared
- Signal response is almost independent of size of sensitive area
- Unaffected by vibration, small in size
- Available in complex and exact arrays and mosaics



For a booklet giving detailed information on Kodak Ektron Detectors, write Military and Special Products Sales,

EASTMAN KODAK COMPANY
Rochester 4, N. Y.

Kodak

For more information circle **138** on inquiry card.

Dielectric Absorption—4 to 5% when measured as follows: Charge one hour, remove from charging source and discharge for one-third second. Measure the maximum recovery voltage.

$$\frac{\text{100 x Max Recovery Voltage}}{\text{Charge Voltage}} = \%\ \text{Dielectric Absorption}$$

Temperature Range— −40° to +105°C.

High Ambient Temperature Rating—

Temperature	% of Rated Voltage
65°C or less	100
85°C	70
105°C	55

(From new 20-page brochure "Plasticon Capacitors", Condenser Products Co., 140 Hamilton St., New Haven, Conn.)

For this literature circle **410** on inquiry card.

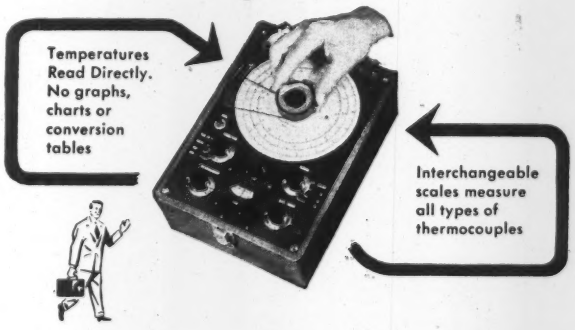
Ferramic Magnetic Cores

The outstanding quality of these cores has earned industry-wide acceptance in the digital computer field and

TABLE OF MAGNETIC PROPERTIES

		FERRAMIC S-1
Initial permeability (1 Mc)	μ_o	40
Maximum permeability (DC)	μ_{max}	515
Saturation Flux Density (DC) gauss	B_s	1780
Retentivity (DC) gauss	B_r	1590
Coercive Force oersteds	H_c	1.5 max.
Switching Time microseconds	τ	1
Br/Bs Ratio		0.90
Maximum Squareness Ratio $\frac{\phi(-Im)}{2} / \phi(Im)$	R_s	0.8
Optimum Magnetomotive Force (oersteds)	H_m	2.0

The only portable potentiometer pyrometer with interchangeable direct-reading scales


Temperatures Read Directly. No graphs, charts or conversion tables
Interchangeable scales measure all types of thermocouples

...checks and calibrates all types of temperature instruments.

"Pyrotest" is the most versatile instrument of its type. Compact, rugged, easy to carry (12 lbs. . . . 12¼" x 9" x 8½"). Accurate to ⅛ of 1%. 5 instruments in one—with a scale for every use, interchangeable in 30 seconds. Self-contained power supply. Write for free Bulletin 112.

TECHNIQUE

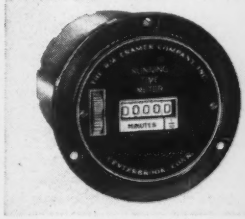
TECHNIQUE ASSOCIATES, INC.
211 E. SOUTH STREET
INDIANAPOLIS 25, IND.

For more information circle **139** on inquiry card.

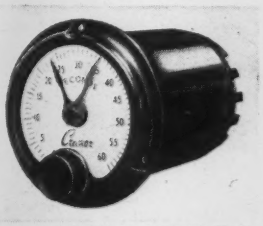
WANTED: Timing Problems

Chances are an economical stock timer (like these from Cramer's unusually flexible line) will meet your needs. If not, our engineers will be glad to work with you on specific problems. Write: Cramer Controls Corporation, Box 5, Centerbrook, Conn. 6.12

NEW INTERVAL TIMER, Type 241, features 12 full-scale time ranges from 6 seconds to 24 hours, easy-to-read dials. Provides push-button start, automatic stop and reset after timed interval.



RUNNING TIME METERS measure elapsed time intervals. Available to register in seconds, minutes, hours, and tenths of same; electrical stop clocks for smaller time intervals.



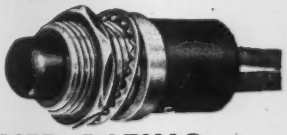
NEW TIME-DELAY RELAY, Type 412, also with ranges from 6 seconds to 24 hours, closes (or opens) a circuit at timed interval after closing control circuit. Nine position terminal block.

TALK IT OVER WITH CRAMER

CRAMER CONTROLS
CORPORATION
(Formerly R. W. Cramer Co.) 6.12

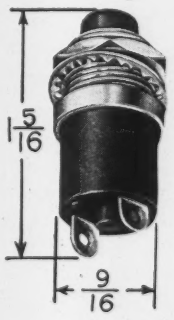
For more information circle **140** on inquiry card.

MONEY SAVING Push-Button SWITCHES



...U.L. APPROVED RATING

8—AMPS., 115 volts, ac.



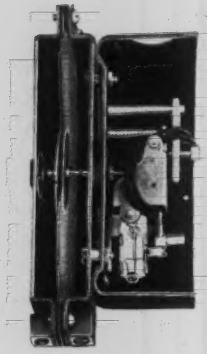
Dress-up instruments, appliances and countless other products with a switch that "feels" and performs like a true Snap-Switch should. Hetherington B-Series push button switches have an exceptionally positive, audible snap action that can't be teased off contact . . . allows full 8-ampere rating in less space than most ½-amp switches. Normally-open or normally-closed SP-ST types available with pigtail leads or lug terminals.

Get complete details. Write for Data Sheet S-4.

Push-button, Rotary, & Toggle Switches
Indicator Lights
Switch-Light combinations

HETHERINGTON INC.
1200 Elmwood Avenue, Sharon Hill, Pa.

For more information circle **141** on inquiry card.



CROSS SECTION

DIFFERENTIAL PRESSURE CONTROL

FOR AIR OR GAS (INCHES OR HUNDREDTHS OF INCHES OF WATER)

Incorporates two pressure chambers separated by a diaphragm. Opens or closes an electrical circuit according to a minute change in the difference between two pressures or vacuums.

Suggested application: Indicate a change in resistance through a filter due to a clogging of the filter—indicate a change in differential across an orifice due to a change in flow conditions—indicate an unbalanced condition of two air ducts.

Operating ranges: 6.0" vac. to 6.0" press., and 30.0" vac. to 30.0" press.

AVAILABLE IN FOUR MODELS

To open or close an electrical circuit upon an increase or decrease in the difference between two gas or air pressures.

To successively open or close two electrical circuits upon an increase or decrease in difference between two air or gas pressures.

To close one circuit on an increase of the difference between two pressures and close one circuit on a decrease of the difference between two pressures.

To open one circuit on an increase of the difference between two pressures and open one circuit on a decrease of the difference between two pressures.

FOR ALL TYPES OF SERVICE

For General Purpose Nema 1; Weatherproof Nema 1A, 2, 3, 4; Explosion-proof (Hazardous Locations) Class 1 Group D, Class 2, Group E, F and G.

Equipped with the famous Mercoid magnetic sealed mercury contact.

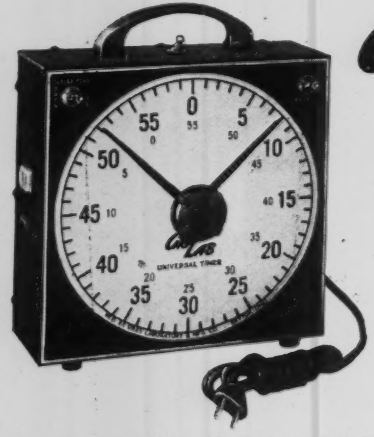
WRITE FOR BULLETIN CA-3P

THE MERCOID CORPORATION

4201 BELMONT AVE., CHICAGO 41, ILLINOIS

For more information circle **142** on inquiry card.

TIME YOUR TESTS IN SPLIT-SECONDS!



GRA LAB

ALL PURPOSE LABORATORY TIMERS

MODELS AT $21.95 TO $26.95

You can set the large 8" dial for any desired time period within an unusually wide range of 3600 possible settings, (ie., 1 sec. to 60 min., 1 min. to 60 hrs., etc.). At end of preset interval, alarm sounds and external load is automatically switched on or off.

Gra-Lab Micro Timers, **Electric Stop Clocks**, are available in 1/10 sec. or 1/1000 min. graduations for split-second measurements of elapsed time in laboratory or production operations. Price $37.50

WRITE FOR COMPLETE CATALOG!

DIMCO-GRAY COMPANY

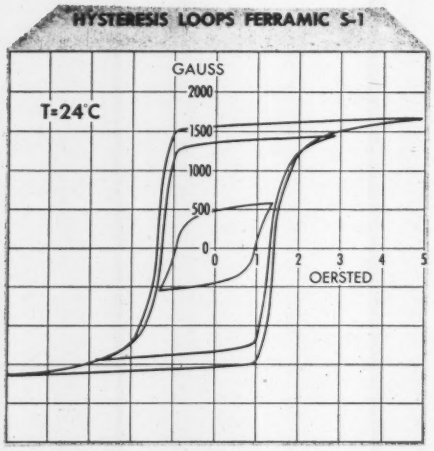
212 E. Sixth St.
DAYTON 2, OHIO

For more information circle **143** on inquiry card.

BRIEFS —CONTINUED

rapidly expanding usage in automation and switching applications.

Ferramic Cores are manufactured under closely controlled procedures which results in a product having a high degree of uniformity. Accurately calibrated production test equipment insures a degree of uniformity in the cores which results in plane assemblies having a low noise level and hence a wide operating margin. Absolute calibration procedures based on calibrated standards insure constant reproducibility. (*From new 4-page Bulletin MT-103, General Ceramics Corp., Keasbey, N. J.*)



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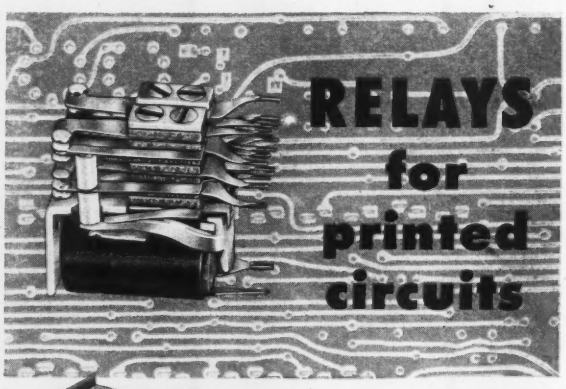
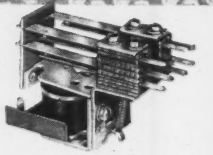




Designed for easy installation and dependable operation. Terminals are an integral part of the switch blade, to prevent loss of continuity or conductivity. Spacing between terminals can be varied to circuit layout. Miniature telephone types for DC operation, chassis or printed circuit board mounting; and general purpose types for AC or DC operation, chassis mounting. Switch combinations up to 6 Form C.

Inquiries Invited

Comar ELECTRIC COMPANY

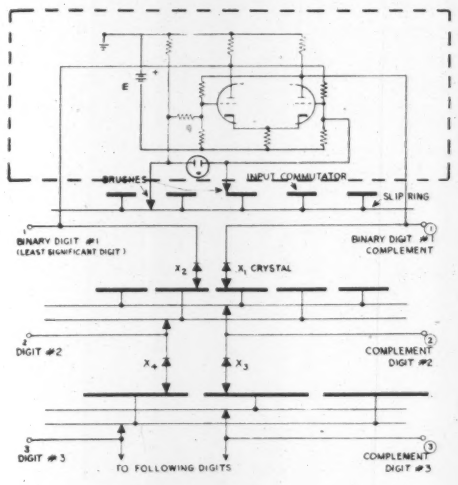
3349 ADDISON STREET, CHICAGO 18, ILLINOIS

RELAYS · SOLENOIDS · COILS · SWITCHES · HERMETIC SEALING

For more information circle **144** on inquiry card.

Analog/Digital Converters

The input to the converter is a shaft rotation; the output is an electrical signal in natural binary code presented in parallel form on 13 terminals. Simultaneously avail-



able on 13 other terminals, is the complement of the output. The total count of 8,192 or 2^{13} is accomplished in 64 revolutions of the input shaft. Accuracy is maintained to within better than the resolution of one part in 8,192 or ±.012%. The input shaft resolution is one part in 128, or 2.8 degrees . . . (*From new 4-page Bulletin 372, Norden-Ketay Corp., Instrument & Systems Div., Wiley St., Milford, Conn.*)

For this literature circle **412** on inquiry card.

STRAIGHT LINE CONTROL

BLUE M'S *REVOLUTIONARY*

POWER-O-MATIC®

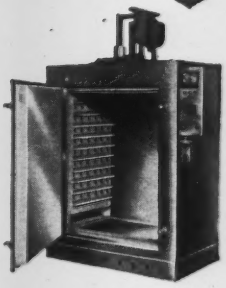
Patents Pending

INDUSTRIAL

BATCH OVENS

- OUTPERFORMS ALL OVENS *Guaranteed*
- 23.8% COST SAVINGS
- AUTOMATIC HEAT RECOVERY
- MULTIPLE FAIL-SAFE FEATURE

IMPROVED PRODUCTS
SUPERB PERFORMANCE



POWER-O-MATIC automatically proportions minimum wattage in relation to temperature and work load. Operator merely sets temperature. No auxiliary switches to set. Nothing to remember. Fully automatic. Faster.

Finest advancement of temperature control in 50 years. Equal to saturable core reactor control action—at much less cost.

● TEMP. RANGE 100° F. to 600° F.

COMPETITIVELY PRICED

Write for "The POWER-O-MATIC Story"

MODELS FROM 16 TO 96 CU. FT.

BLUE 'M' LINE

BLUE M ELECTRIC CO.

138th AND CHATHAM ST. BLUE ISLAND, ILL.

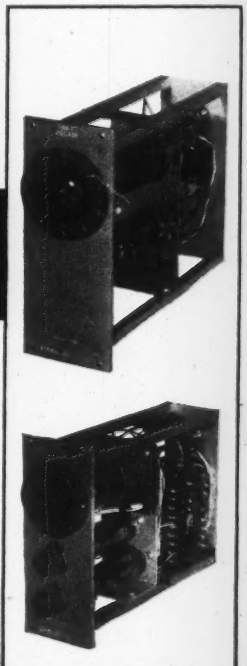
Manufacturer of ovens, furnaces and related temperature controlled equipment.

For more information circle **146** on inquiry card.

BAIRD ATOMIC

PLUG-IN COUNTING STRIPS

BUILDING BLOCKS FOR YOUR COUNTING AND CONTROL SYSTEMS



Baird-Atomic offers wide selection of unitized plug-in strips for all industrial counting and control applications. Over 25 strips offer an unparalleled choice for the system designer.

Input, counting, pre-set, and output strips for decade and duo-decade counting and control with counting speeds up to 20,000 cps are available in the B-A plug-in design. B-A also offers a wide choice of cabinets with built-in power supplies.

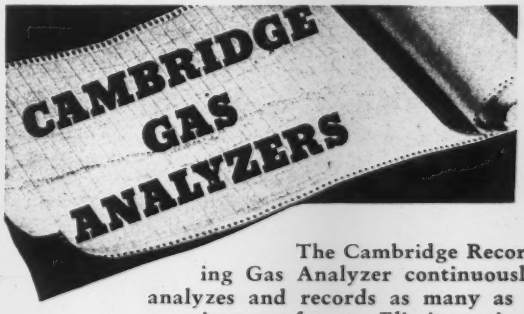
Ask for Industrial Counting Bulletin.

Representatives in principal cities — U. S. and abroad.

Baird - Associates - Atomic Instrument Co.

33 UNIVERSITY ROAD, CAMBRIDGE 38, MASSACHUSETTS

For more information circle **145** on inquiry card.



The Cambridge Recording Gas Analyzer continuously analyzes and records as many as six constituents of a gas. Eliminates intermittent, slow and expensive manual gas analysis. Accurate . . . Sensitive . . . Simple. No moving parts; utilizes thermal conductivity principle.

Makes possible substantial savings in the operation of kilns, production of inert gases, and in metallurgical, petroleum, and other chemical processes. Single- and Multi-point instruments are available for a wide variety of applications.

Send for literature mentioning application

CAMBRIDGE

INSTRUMENT COMPANY, INC.

3526 Grand Central Terminal, New York 17

Pioneer Manufacturers of

PRECISION INSTRUMENTS

For more information circle **147** on inquiry card.

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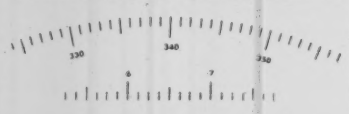

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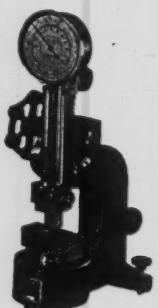

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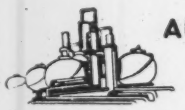
For more information circle **149** on inquiry card.

INSTRUMENTS and AUTOMATION

New Literature

AUTOMATION



Process Equipment. New 12-page Brochure ND46-700 presents all L&N instruments for chemical process applications, including Speedomax loggers, scanners, recorders, various process gas analyzers, and process control systems; also all primary elements.—Leeds & Northrup Co., 4907 Stenton Ave., Phila. 44, Pa.

Circle **413** on inquiry card.

Furnace Control. New 4-page Bulletin 33.2 describes arc furnace control; 8-page Bulletin 33.1 describes edge control for strip; 8-page Bulletin 38.1 describes "Electrojet" for obtaining powerful hydraulic output from low-level electrical input signals.—Askania Regulator Co., 240 E. Ontario St., Chciago 11, Ill.

Circle **414** on inquiry card.

Control Unit. New 4-page brochure presents the "Swisstrol" electronic-hydraulic control unit for high-accuracy pressure, level, temperature, flow, condensate control, etc.—The Swiss Colony Engineering Div., Monroe, Wisconsin.

Circle **415** on inquiry card.

VALVES

Diaphragm Control Valve. New 4-page Bulletin 980 presents maker's Type 30 Diaphragm Control Valve for pressure reduction and regulation of steam, water, air, etc. gives sizes, specs., dimensions, ratings, etc.—A. W. Cash Co., P. O. Box 551, Decatur, Ill.

Circle **416** on inquiry card.

Control Valves. New 12-page Bulletin LB-2 presents makers' complete line of Series LB control valves, including details on construction and operating characteristics.—Conoflow Corp., 2100 Arch St., Phila. 3, Pa.

Circle **417** on inquiry card.

Solenoid Valves. New 2-page Bulletin 8264 illustrates and specifies new two-way shut-off solenoid valve for liquid CO_2 in cooling applications.—Automatic Switch Co., Orange, N. J.

Circle **418** on inquiry card.

Control Valves. New 4-page Bulletin 116 presents maker's air operated small flow bar stock control valves especially suited for use in research development laboratories, and pilot plants.—Uniflow Valve Corp., Cranford, N. J.

Circle **419** on inquiry card.

Valves. New 52-page Catalog No. 1500-C contains full information on the complete line of fluid control valves to meet every installation requirement, including Domotor valve, cylinder valve, check valve, handwheel valve, etc.—The Annin Co., 6570 Telegraph Rd., Los Angeles 22, Calif.

Circle **420** on inquiry card.

Precision Valves. New Brochure #S-2021-R describes maker's line of valves with illustrations and technical information.—Circle Seal Products Co., Inc., 2181 E. Foothill Blvd., Pasadena, Calif.

Circle **421** on inquiry card.

Solenoid Valves. New 8-page Bulletin W-7-A describes and specifies maker's cushioned solenoid valves available in sizes from ½" to 2" and 2½" through 36" for quenching, fuel lines, water level control etc.—Golden Anderson Valve Specialty Co., 1232 Ridge Ave., Pittsburgh 33, Pa.

Circle **422** on inquiry card.

Check, and Relief Valves. New 4-page Brochure S-2021 R presents Circle Seal precision check, shuttle, relief, and shutoff valves.—Circle Seal Products Co., Inc. 2181 E. Foothill Blvd., Pasadena, Calif.

Circle **423** on inquiry card.

Valves. New 72-page Bulletin 156 presents maker's line of hydraulic and pneumatic valves, such as restrictor, sequence, check, brake control and parking, and shut-off valves and other hydraulic and pneumatic components.—Aircraft Products Co., 300 Church Rd., Bridgeport, Pa.

Circle **424** on inquiry card.

Relief Valves. New 2-page Bulletin 1255-B presents design features, specifications and dimensions of ¼" through 1" relief valves and back pressure valves.—Milton Roy Co., 1300 E. Mermaid Lane, Phila. 18, Pa.

Circle **425** on inquiry card.

Servo Valve. New 4-page bulletin presents maker's dry coil servo valve for use in high performance stabilization and control systems with principal features and specifications.—Hydraulic Research & Mfg. Co., 2835 N. Naomi St. Burbank, California.

Circle **426** on inquiry card.

Hydraulic Control Valves. New 4-page bulletin gives specifications and dimensions of hydraulic control valves—In-line Type and Standard Snap-Action Pressure Switches; Manual Shut Off, Solenoid Operated Shut Off, 3-way Pressure Operated, Priority and Relief Valves.—Hydraulic Research & Mfg. Co., 2835 N. Naomi St., Burbank, Calif.

Circle **427** on inquiry card.

Air Valves. New 30-page booklet is written in layman's non-technical language and covers parts, structure and action of simple and more complicated valves.—Mechanical Air Controls, Inc., 10030 Capital, Oak Park, Detroit 37, Mich.

Circle **428** on inquiry card.

Instrument Valves. New 2-page pamphlet 51856 introduces instrument valves for gases and liquids featuring positive, non-leak, fingertip control, in the range of −100 to +500°F and up to 3000 psig.—Robbins Aviation, 1735 W. Florence Ave., Los Angeles 47, Calif.

Circle **429** on inquiry card.

Pressure Regulators. New 4-page Bulletin MMR-56 explains how pressure reducing and relief valves aid plastic molding operations. Contains also description of Type "E", high pressure reducing valve.—Atlas Valve Co., 280-284 South St., Newark, N. J.

Circle **430** on inquiry card.

MOTORS

Motors. New special motor bulletin and "Engineering Data Sheet" present "application-engineered" motor characteristics in fractional-hp motors with intended motor application and required motor specifications.—R. A. Boehm Co., Engineering Dept., 58 Brooklyn Ave., Merrick, L. I., N. Y.

Circle **431** on inquiry card.

Adjustable-speed Drive. New 2-page bulletin presents maker's adjustable-speed drive and dc tachometer generator.—Servo-Tek Products Co. Inc., 1086 Goffle Rd., Hawthorne, N. J.

Circle **432** on inquiry card.

RECORDERS

Millivolt Recorders. New 4-page Data Sheet #-ND46(6) describes makers' line of Speedomax G Millivolt Recorders—including stocked 0-10 Millivolt Recorders; 1, 2 and 3-cycle d-c Logarithmic Recorders; Zero Suppressed or Zero Elevated Ranges instruments; Medium High Impedance Recorder and Low Level d-c Microvolt Recorder.—Leeds & Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.

Circle **433** on inquiry card.

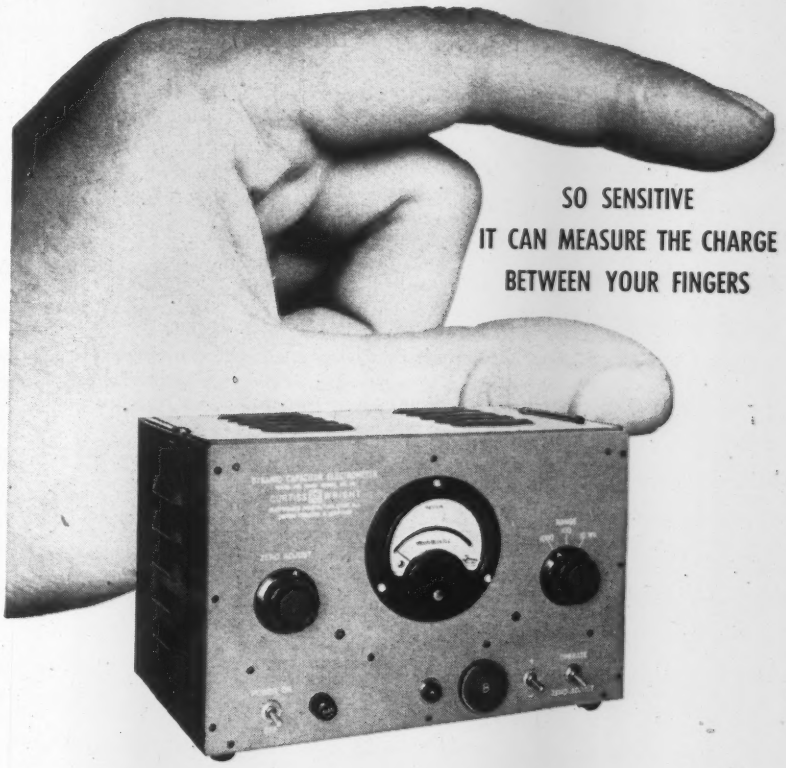
Infrared Analyzer. New 8-page Folder N-91-620 (1) describes maker's Infrared Analyzers for monitoring metallurgical atmosphere through continuous measurement of gas components from the output of endothermic or exothermic generators or in the furnace itself.—Leeds & Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.

Circle **434** on inquiry card.

Strip Chart Recorder. New 4-page brochure illustrates and specifies maker's new G-11 Strip Chart Recorder for panel mounting, rack mounting, or portable use.—Varian Associates, Instrument Division, Palo Alto, Calif.

Circle **435** on inquiry card.

Facsimile Transmission. New 2-page bulletin (reprint) presents



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The Curtiss-Wright Dynamic Capacitor Electrometer is ideal for measuring minute currents or voltages from high impedance sources. There is no 60 cps interference since the Dynamic Capacitor Electrometer operates at 1,000 cps. The instrument can be used to measure static charges, potentials of floating grids, insulation leakage currents, capacitor dielectric leakages; and to study transistors and diodes. Its ruggedness, reliability, and high sensitivity make it especially suited for use in the nuclear field as a component in reactor control systems and in industrial control systems employing radioisotopes as energy sources. It can be used for pH determination, and in mass spectrometry. In biophysics and medicine it may be used to measure cell potentials, skin potentials, streaming potentials, injury potentials, and nerve impulses. Besides providing an indication on its own meter, it will operate any standard recorder. For details, write Nuclear Equipment Sales Dept., Curtiss-Wright Corporation, Electronics Division, Carlstadt, N. J.

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60 OR 400 CYCLES

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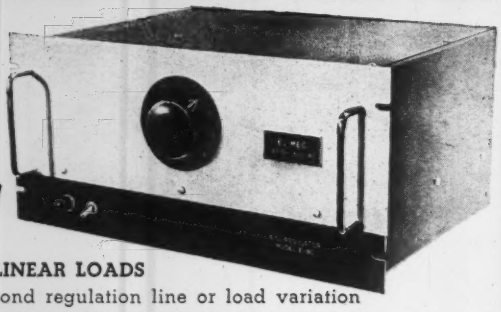

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- PROVEN by continuous trouble free use in automatic equipment

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Model	Specifications		
E-80-1	115 V.	1.5 Amp.	60 Cycles
E-80-1V	Variable 50-125 V.	1.5 Amp.	60 Cycles
E-80-2	115 V.	2.5 Amp.	60 Cycles
E-80-2V	Variable 50-125 V.	2.5 Amp.	60 Cycles
E-84-2	115 V.	2.5 Amp.	400 Cycles

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speed and accuracy advantages of maker's facsimile scanners and recorders in many applications.—Alden Electronic & Impulse Recording Equipment Co., Alden Research Center, Westboro, Mass.

Circle **436** on inquiry card.

Oscillographic Recorder. New 8-page brochure "The Acton 550-A" describes maker's 8 channel, direct-writing, direct-reading, oscillographic recorder with frequency response up to 1000 cps.—Acton Labs., Inc., Acton, Mass.

Circle **437** on inquiry card.

Tape Recorder. New 4-page Circular 5709 presents maker's "Magnemite" portable, battery-operated, spring-motor tape recorders which come in single and multi-speed (2, 3 or 4-speed) models.—Amplifier Corp. of America, 398 Broadway, New York 13, N. Y.

Circle **438** on inquiry card.

Indicators, Recorders. New 2-page Data Sheet ND 46-51 (100) describes maker's "Speedomax H" electronic potentiometer-type indicators, recorders and controllers for multivoltage output.—Leeds & Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.

Circle **439** on inquiry card.

Recording Controllers. New 4-page illustrated Bulletin 979 describes maker's line of pressure and temperature recorders and controllers.—A. W. Cash Co., P. O. Box 551, Decatur, Ill.

Circle **440** on inquiry card.

Recording Oscillographs. Three new bulletins describe and illustrate maker's recording oscillographs: 12-page Bulletin 1536B covers the precision "Type 5-119"; 16-page Bulletin 1500D covers "Type 5-114" for static or dynamic data; and 4-page Bulletin 1533B covers "Type 5-117" for low cost recording.—Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle **441** on inquiry card.

Electrodynamic Recorder. New 2-page Bulletin 1023-1 describes maker's direct inking, 2 channel electrodynamic recording milliammeter.—Massa Labs., Inc., Hingham, Mass.

Circle **442** on inquiry card.

TEMPERATURE

Thermal Conductivity Analyzers. New 16-page Bulletin TD-507 presents information on the practical application and operation of maker's analyzers for determination of thermal conductivity of gases. Includes calculation method and table for 68 gases.—Arnold O. Beckman, Inc., 1020 Mission St., So. Pasadena, Calif.

Circle **443** on inquiry card.

Portable Temperature Indicators. New 2-page Data Sheet ND42-33(1) describes maker's portable temperature indicators for thermocouple measurements up to 3000°F; includes specifications, ranges and replacement parts.—Leeds & Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.

Circle **444** on inquiry card.

Temperature Controllers. New 4-page Brochure MC-139 describes and

specifies new high-performance liquid filled temperature controllers with single, double or multiple circuit control; four-switch types with control accuracy 1%.—Fenwal, Inc., Ashland, Mass.

Circle **445** on inquiry card.

Thermostats. New 4-page Bulletin MC-137 presents the standard cartridge-type Thermoswitch and a lower cost rectangular model which are encased in plastic for service in highly humid or corrosive environments, immersion in acids, alcohols etc.—Fenwal, Inc., Ashland, Mass.

Circle **446** on inquiry card.

Thermostat Testing Equipment. New 4-page Bulletin MC-133 presents four types of portable kits for testing and calibrating thermostatic controls and fire detectors.—Fenwal, Inc., Ashland, Mass.

Circle **447** on inquiry card.

Overheat Detectors. New 4-page Bulletin MC-130 illustrates and specifies maker's aircraft fire and overheat detectors (Series 17343) for commercial and military aircraft.—Aviation Products Div., Fenwal, Inc., Ashland, Mass.

Circle **448** on inquiry card.

Thermal Time Delay Relay. New 2- and 4-page bulletins BO-316G and BO-316M describe snap action thermal time delay relays; 2-page Bulletin J326T describes snap action thermostatic switch.—Curtiss-Wright Corp., Electronics Div., 631 Central Ave., Carlstadt, N. J.

Circle **449** on inquiry card.

Surface Thermometer. New 2-page Form 2P756 describes maker's pyrocouple, a one-second surface contact-type thermometer with full-scale indication on a one-second surface contact.—Royco Instruments, 819 Arthur St., Albany, Calif.

Circle **450** on inquiry card.

Constant Temperature Baths. New 6-page Bulletin 300A with supplement describes mechanically refrigerated constant-temperature bath with control accuracy ± 0.002°C.—Apex Scientific Co., 59 Donna Maria Way, Orinda, Calif.

Circle **451** on inquiry card.

Gas Thermostat. New 4-page Bulletin RT-814 presents gas thermostat Model DP for accurate throttling control of commercial cooking equipment and various industrial applications.—Robertshaw Fulton Controls Co., 110 E. Otterman St., Greensburg, Pa.

Circle **452** on inquiry card.

PRESSURE, VACUUM

Test Gauges. New 8-page Catalog No. 400 presents test gauges for fluid pressure measurement in laboratories, production testing, field inspections, test stands, and recalibration benches.—United States Gauge Div., American Machine & Metals, Inc., Sellersville, Pa.

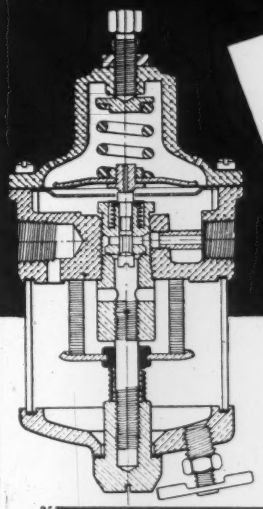
Circle **453** on inquiry card.

Pneumatic Instruments. New 16-page Catalog 505 presents maker's line of pneumatic instruments for process control—pilot controllers,

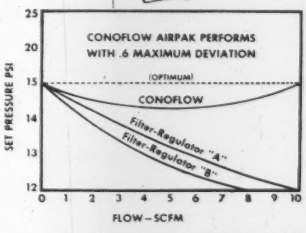
COMPARISON PROVES . . .

CONOFLOW AIRPAK
FILTER-REGULATOR
LEADS the FIELD
in

- DESIGN
- PERFORMANCE
- LONG LIFE OPERATION



The Conoflow Airpak is a moderately priced combination reducing-relief type regulator and air filter. It is used with pneumatic controllers and in many other services requiring clean, filtered air at a regulated pressure. The Airpak surpasses all other filter-regulators in its price range for efficiency, compactness and all-around ruggedness. Check the comparison charts below:



DROOP CURVES

The unique design of the Airpak inner valve and porting provides exceptionally flat droop curves and exceedingly accurate pressure regulation, despite wide variations in flow and upstream pressures, thus insuring smooth performing instrument operation. Even flatter droop curves can be supplied for special requirements.

DESIGN COMPARISON CHART

	Conoflow Model FH-20 Airpak	Filter-Regulator "A"	Filter-Regulator "B"
Flow Capacity	15-17 cfm	16-20 cfm	12-14 cfm
Regulator Inner Valve	Polished Stainless Steel	Rubber Seated Brass	Rubber Seated Brass
Filter Area	5 sq. in. std. Convertible to 9 or 27 sq. in. in field	3.5 sq. in. Fixed area Not convertible	3.25 sq. in. Fixed area Not convertible
Dripwell Volume	5 cu. in. std. Convertible to 9 to 30 cu. in.	6 cu. in. Fixed volume Not convertible	4.5 cu. in. Fixed volume Not convertible
Number of Outlet Conns.	3	2	1
Assembly	Single bolt	Single bolt	Four bolts

The Airpak gives longer, trouble-free service and is less susceptible to corrosion because of its rugged construction and the use of a stainless steel inner valve instead of a rubber-seated disc. Filter medium is quickly replaced by simply loosening one bolt and inserting new element; or, if larger filter areas or more dripwell capacity is required, conversion parts can be substituted in the field without removing filter body from the line.

WRITE FOR BULLETIN H-2 CONOFLOW PNEUMATIC REGULATORS

C-600

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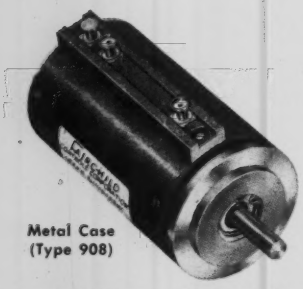

Metal Case (Type 908)

Fairchild now gives you a choice of metal or phenolic case 10-turn precision potentiometers. The rigidity of metal case construction provides *maximum* life and sustained accuracy. The phenolic case units offer the high accuracy and reliability needed to meet normal life requirements at a lower cost. To select the best unit for your application, write for more information on both metal and phenolic case potentiometers today.

TWO NEW 7/8", TEN-TURN POTENTIOMETERS

Fairchild Type 907 Phenolic and Type 908 Metal Case Precision Potentiometers are ⅞"-diameter units with 3600° electrical rotation. Type 907 has a linearity range of 0.1% to 0.50%; Type 908 has a linearity range of 0.05% to 0.25%. Both are rated at 2 watts at 40°C. Standard units rated to +85°C; higher temperature requirements can be obtained on special order. Resistance ranges from 100 to 100K ohms.

Phenolic Case (Type 907)

Write: Dept. 140-79B1, Fairchild Controls Corp., Components Division, 225 Park Avenue, Hicksville, Long Island, New York. West Coast: 6111 E. Washington Blvd., Los Angeles, California.

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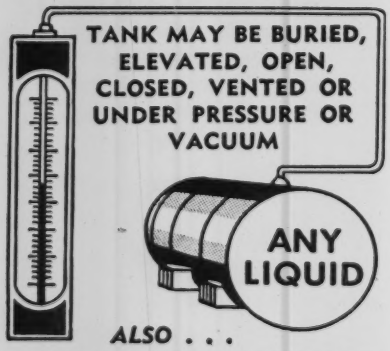

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For more information circle **156** on inquiry card.

NEW LITERATURE

transmitters, receiving gages, and recording controllers.—United States Gauge, Sellersville, Pa.

Circle **454** on inquiry card.

Vacuum Pumps. New 24-page Bulletin 9 charts and describes company's vacuum pumps with information for the laboratory planning the installation of high vacuum systems; includes price list.—Central Scientific Co., 1700 Irving Park Rd., Chicago, Ill.

Circle **455** on inquiry card.

Vacuum Pumps. New 8-page Bulletin 5H3 describes maker's three, four, and five stage Steam Jet Vacuum Pumps and Vacuum Boosters, condensing and non-condensing types.—Dept. J-Z, Schutte and Koerting Co., Cornwells Heights, Bucks County, Pa.

Circle **456** on inquiry card.

High Vacuum Pumps. New 28-page Catalog 752 presents vacuum processing data on Stokes high vacuum pumps including specifications, tables of formulas, constants, conversion factors, and solutions to problems of pump selection.—F. J. Stokes Corp., 5500 Tabor Rd., Phila. 20, Pa.

Circle **457** on inquiry card.

Air Cylinders. New 2-page leaflet describes low-cost Bimba stainless steel non-repair Model 091 air cylinder for clamping, moving, holding, ejecting, pushing, etc.—BIMBA Hardware & Mfg. Co., 101 Main St., Monee, Ill.

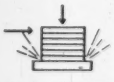
Circle **458** on inquiry card.

Thermocouple Vacuum Gage. New 2-page bulletin describes thermocouple vacuum gage with range from 0.5 microns to 1,000 microns Hg.—Arthur F. Smith Co., Rochester 3, N. Y.

Circle **459** on inquiry card.

Gauge Snubber. New Bulletin presents new Chemiquip high pressure gauge snubbers.—Chemiquip Co., 460 W. Broadway, New York 12, N. Y.

Circle **460** on inquiry card.



WEIGHT FORCE,

Automatic Bagging Scale. New 2-page Data Sheet No. 5601 describes maker's Model HA-39 fertilizer scale, capable of bagging up to 24 sacks per minute.—Richardson Scale Co., Van Houten Ave., Clifton, N. J.

Circle **461** on inquiry card.

Force Transducers. New 2-page Bulletin #140 presents maker's Series 140 Force Transducers including theory of operation, applications information, and complete electrical and physical specifications.—Daytronic Corp., 216 So. Main St., Dayton 2, Ohio.

Circle **462** on inquiry card.

Force Meters. New 2-page Bulletin F1 describes Model 150 and Model 300 "Forcometer", for measuring mechanical loads and applied forces.—Charles W. Schneible Co., 32 Lee Court, New Rochelle, N. Y.

Circle **463** on inquiry card.

Truck Weighing Systems. New 4-page Bulletin 509 presents two systems for static and dynamic weighing of trucks. Electronic Readout and Data Recording Systems for both models are available, designed to print or punch desired data.—Taller & Cooper, Inc., 75 Front St., Brooklyn 1, N. Y.

Circle **464** on inquiry card.

Hook Scale. New 4-page Bulletin M-25 presents new kind of low cost hook scale, Type SU-20 Sensater, a hydraulic scale which is accurate enough to be certified.—Martin-Decker Corp., 3431 Cherry Ave., Long Beach 7, Calif.

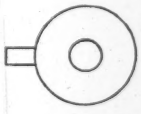
Circle **465** on inquiry card.

Continuous Weighing. New 4-page brochure describes maker's "Electro Way" Continuous Weighing Systems for weighing material electronically on a conveyor belt.—Bell Automation Corp., 749 Monroe Ave., Rochester 7, N. Y.

Circle **466** on inquiry card.

Weighing Systems. New 12-page Bulletin 561 presents practically every possible arrangement of Emery Tank and Bin Weighing Systems in use; describes also system "package", and "rolling ball" construction of Emery cell.—The A. H. Emery Co., New Canaan, Connecticut.

Circle **467** on inquiry card.



FLOW

Flow Transmitters. New 6-page Bulletin 170 presents Brooks Transi-Twins, interchangeable Mag/Nu/Matic Pneumatic Transmitter and Elec/Tru/Matic Electric Transmitter. Also meter sizes, flow capacities, dimensions.—Brooks Rotameter Co., Lansdale, Pa.

Circle **468** on inquiry card.

Rotameters. New 12-page Bulletin 18RG presents maker's line of Series 18200 "Safeguard" "variable area" type flowmeters.—Dept. M-E, Schutte and Koerting Co., Cornwells Heights, Bucks County, Pa.

Circle **469** on inquiry card.

Gas Flowmeter. New 8-page Bulletin SC-1022 the Series F Selas Flo-Scope for indicating flow rate of air and gases with minimum pressure drop.—Selas Corp., Dresher, Pa.

Circle **470** on inquiry card.

Sight Flow Indicators. New 2-page bulletin illustrates sight flow indicators, including flapper, rotary and drip types.—Jacoby-Tarbox Corp., 808 Nepperhan Ave., Yonkers, N. Y.

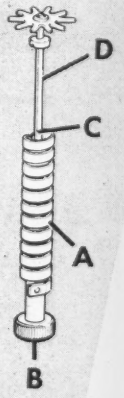
Circle **471** on inquiry card.

LEVEL

Gages, Indicators. New 6-page Bulletin 8-1-56 presents maker's line; includes flow indicators, gages, gage valves, gage glasses, cocks, etc.—Ernst Water Column & Gage Co., Livingston, N. J.

Circle **472** on inquiry card.

Water Gages. New 6-page Bulletin WG-1814 describes company's Color-Port Water Gages for boiler pres-



HOW CHACE THERMOSTATIC BIMETAL ACTUATES THE

Marsh

BOILER GAUGE

This neat Type 23 D S Q T boiler gauge is a product of James P. Marsh Corporation, manufacturers of temperature indicating devices for industry and the home. The Ther-Alti-Meter shows altitude and steam pressure and boiler temperature, all on one compact dial. The temperature gauge is actuated by an element made of dependable Chace Thermostatic Bimetal for accuracy and many years of continuous performance.

Here's how it works: The helical coil element of Chace Thermostatic Bimetal (A) is welded to a knurled brass plug (B) which is a press fit in the immersion tube. The free end (C) fits into the slotted end of the shaft (D) which is geared to the temperature indicator hand. The bending action of the bimetal in the coil causes the upper end to turn counter-clockwise as the temperature rises, thru rotating the shaft. The element is geared so that it rotates the indicator 180° between the range of 60° and 320° F.

Remember Chace when you design for temperature actuation or indication, or for protection of valuable equipment. Dependable Chace Thermostatic Bimetal is available in 28 types, in strip, coil or completely fabricated and assembled elements made to your specification. Write for new 44-page booklet, "Successful Applications of Chace Thermostatic Bimetal," containing interesting uses of bimetal and many pages of engineering data.

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Thermostatic Bimetal
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For more information circle **157** on inquiry card.

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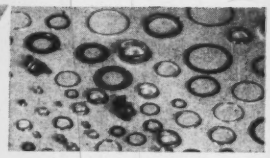
NEY



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ENGINEERED CONTACTS, SLIP RINGS & ALLOYS

Ney designs and makes to customers' specifications sliding contacts, slip rings and assemblies, commutator segments and assemblies, brush and brush holder assemblies, and precious metal resistance wire. Consult Ney's Engineering Dept. and find out how precious metals can improve your products.

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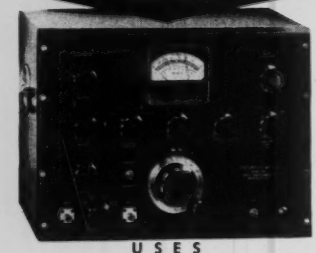
FREED DISTORTION METER NO. 1410



USES

The Type 1410 Distortion Meter may be used in the laboratory or in production testing of receivers, amplifiers and oscillators.

Frequency Range: 20 kc to 1 mc.

Input Impedance: 500,000 ohms shunted by 70 mmfd. (plus capacity of input cable) on all ranges but the 0.1 volt range. The shunt capacity on this range is 800 mmfd.

Accuracy: Harmonic Distortion can be measured accurately to 0.1%.

Sensitivity: Distortion levels of 0.1% can be read accurately for a signal input as low as 0.2 volts. Maximum input signal is 1000 volts rms.

Elimination Characteristics: Eliminates fundamental completely while attenuating second harmonic approximately 3%.

Send for NEW 48 page transformer catalog. Also ask for complete laboratory test instrument catalog.

FREED TRANSFORMER CO., INC.

1717 Weirfield St., Brooklyn (Ridgewood) 27, N.Y.

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GOODYEAR ATOMIC CORPORATION

ENGINEERS and PHYSICISTS

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Several engineers and physicists with extensive background in the fundamentals of analytical and laboratory research and development are needed for activities involving:

Computers, automatic controls, electromechanical designs.

Electronic circuit design and analysis. Development and application of transistor circuitry.

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Send comprehensive resume indicating qualifications, minimum salary requirement and availability for interview. All replies held in strict confidence.

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NEW LITERATURE

sures to 3300 psi.—Yarnall-Waring Co., Chestnut Hill, Phila. 18, Pa.

Circle **473** on inquiry card.

Level Sight Gages. New 12-page folder includes bulletins describing sight gages, clarifier unit, reservoirs, breather caps, etc.—Century Hydraulics, Inc., 7703 Lyndon Ave., Detroit 38, Mich.

Circle **474** on inquiry card.

MOTION

Motion Transducers. New 2-page Form CMP-656 describes how maker's magnetic pickups generate electrical energy from mechanical motion without contact.—Electro Products Labs., 4500 N. Ravenswood Ave., Chicago 40, Ill.

Circle **475** on inquiry card.

Displacement Transducers. Two new Specification Sheets (1108 and 1109) present Minatron Differential Transformers in std., miniature and sub-miniature designs, featuring infinite resolution, Teflon leads, and epoxy potting. "Technical Application Notes" also available—Minatron Corp., Belle Mead, N. J.

Circle **476** on inquiry card.

AIR, MOISTURE

Moisture Control. New 2-page technical data sheet EH-67-0 (T) outlines new method of continuous moisture control in streams of natural gas plants with the aid of new Beckman Electrolytic Hygrometer.—Scientific Instruments Div., Beckman Instruments, Inc., Fullerton, Calif.

Circle **477** on inquiry card.

Humidity Conditioning. New 4-page booklet K-856 describes Kathabar humidity conditioning system which removes 97% of micro-organisms from air for processes, comfort, health.—Surface Combustion Corp., Toledo 1, Ohio.

Circle **478** on inquiry card.

Humidification. New 4-page Bulletin No. 492 presents pertinent facts on the subject of humidification, including industrial humidifiers available.—Abbeon Supply Co., 179-15A Jamaica Ave., Jamaica 32, N. Y.

Circle **479** on inquiry card.

Moisture Indicator. New 2-page bulletin and supplements (Forms 1231 and 1233) describe transistorized "Moisturometer", a direct-reading moisture-percentage meter for granular materials.—Henry Francis Parks Lab., Portland 15, Oregon.

Circle **480** on inquiry card.

Humidity Sensor. New 2-page brochure describes a new type of electric humidity measuring element "(Hygropak)" with thin film coating over grid electrodes.—Photo-Crystals, Inc., Geneva, Ill.

Circle **481** on inquiry card.

Air Filters. New Bulletin 557-D treats cleaning method of ordinary atmospheric air by means of specially

adapted industrial cloth-filter-type dust collectors.—Wheelabrator Corp., Mishawaka, Ind.

Circle **482** on inquiry card.

VIBRATION, BALANCING

Dynamic Balancing. New 6-page brochure presents "Mogul" and production type Series 500 dynamic balancing machine for rotating parts from 1 to 30 feet length and 10 to 10,000 lb weight.—Raydyne Corp., 920 W. Laurel St., Springfield, Ill.

Circle **483** on inquiry card.

Vibration Analysis. New 6-page Bulletin No. 124E presents both vibration pickups and meters for precise vibration analysis. Includes table of natural frequency, damping, d-c coil resistance, etc. of pickups.—MB Mfg. Co., 1060 State St., New Haven 11, Conn.

Circle **484** on inquiry card.

Vibration Testing. New 4-page brochure presents Model 103A Slip-Sync which provides completely automatic synchronization of stroboscopic lights for watching shake tests in slow motion.—Chadwick-Helmuth Co., 472 E. Duarte Rd., Monrovia, Calif.

Circle **485** on inquiry card.

SOUND, NOISE

Low-Frequency Probe. New 2-page leaflet pictures and describes maker's "SonoProbe" correlator for noise or vibration measurements.—Advanced Electronics, Inc., 94 Silas Deane Highway, Rocky Hill, Conn.

Circle **486** on inquiry card.

Loudspeakers, Dividing Networks. New 6-page Sales Catalog SC502 describes maker's enclosures, dividing networks, high and low drivers and extended range speakers.—James B. Lansing Sound, Inc., Los Angeles 39, Calif.

Circle **487** no inquiry card.

Noise Generator. New 2-page bulletin describes maker's "Model 201" low-frequency Gaussian noise generator.—Electronic Associates, Inc., Long Branch, N. J.

Circle **488** on inquiry card.

Sound Powered Telephones. New 8-page Catalog No. 400-D presents sound powered telephone systems, for distances to 30 miles and more.—United States Instrument Corp., Charlottesville, Va.

Circle **489** on inquiry card.

SPEED, COMPUTING, TIME

Static Speed Control. New 4-page Bulletin GEA-6275 presents static speed control for paper machines. Advantages: High accuracy, high speed of response, low drift, and highly-dependable performance.—General Electric, Schenectady, N. Y.

Circle **490** on inquiry card.

Speed Recorders. New Data Sheet ND46-27(100) describes electronic Speedomax H indicators and recorders now available for precise measurement of rotational or linear speeds, also tachometer generators.—Leeds & Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.

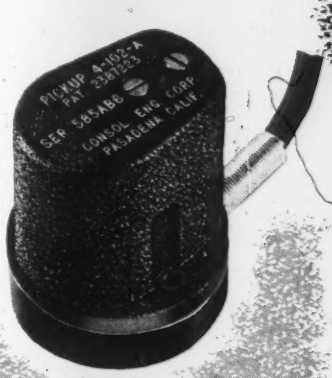
Circle **491** on inquiry card.

G-Accelerators. New 10-page Technical Data Sheet 16 and 14-page Data

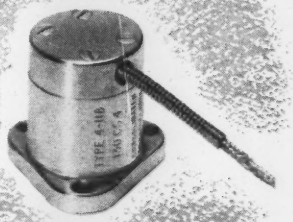
Get reliable accuracy in any vibration test

Precision engineered, but containing no critical bearing surfaces or fragile parts, Consolidated Vibration Pickups insure reliable, trouble-free performance in severe environmental conditions. Electrical output from these self-generating pickups may be read out on any Consolidated Vibration Meter, or through CEC Galvanometers, Amplifiers, or Magnetic Tape Recorders.

CEC VIBRATION PICKUPS



TYPE 4-102A is recommended where axis orientation may change during the course of a test and where a wide range of vibration is encountered. Range is 8 to 700 cps at amplitudes up to 2 inches, with operation from 0° to 150°F. Weight is 10 oz. Unique design insures friction-free operation capable of withstanding transverse accelerations to 35 g's. Applications range from jet engines to heavy machinery. CEC's Type 4-103 is similar, but designed for ambient temperatures of 150° to 250° F. Write for Bulletin CEC 1546-X16.



TYPE 4-118 is especially designed for wide temperature variations (−65° to +500°F). This miniature 1" pickup weighs less than 1½ ounces and is recommended for all applications where temperature is a factor, where space is severely limited, or where a heavier pickup would invalidate test results. Range is 50 to 500 cps at amplitudes up to 0.12 inch. Precision construction includes gold-plated bearing surfaces for almost frictionless movement on sapphire bearings. Write for Bulletin CEC 1535-X24.

Consolidated Electrodynamics

CEC

300 North Sierra Madre Villa, Pasadena, California

NATIONWIDE COMPANY-OWNED SALES & SERVICE OFFICES

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TECHNICAL ELECTRONICS CORPORATION

AUTOMATIC SYSTEM ANALYZER

FOR ACCURATE TESTING OF ALL ELECTRONIC CIRCUITRY OF R, L, & C — CONTINUITY, LEAKAGE, SHORT AND HI-POT.

Equipment is available for automatic testing up to 20 circuits per second of R, L, & C and combination.

System Analyzer produces rapid speed comparison test and malfunctions may be indicated on a Clary tape printer. Designed for testing high production of Radio-Television and other electronic products.

Write now for a complete catalog for your special requirements.

TECHNICAL ELECTRONICS CORP.
4060 Ince Blvd., Culver City, California

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From the Principality of Leichtenstein Swiss Customs Area

ROLYN ARCADIA (Calif.)

Front Surface Mirrors, Cold Mirrors, Achromatic Beam Splitters, Dichroic Beam Splitters, Monochromatic Interference Filters, Wedge Interference Filters, Heat-Reflecting Interference Filters, Cut-Off Filters, Anti-Reflection Coatings, Heat Protective Coatings and many other thin layers.

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Balzers means research in high vacuum process

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GLASS CYLINDERS RODS • TUBES
CIRCLES & SPECIAL SHAPES

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CRYSTAL GLASS TUBE & CYLINDER CO.
7318 South Chicago Ave. • Chicago 19, Ill.

For more information circle **163** on inquiry card.

NEW LITERATURE

Sheet 11 present specifications and performance data for maker's 2 models G-accelerators. 6-page Sheet describes Rate of Turn Tables, 4-page Sheet 13 specifies Accelerometer; all include price lists.—Genisco Inc., Los Angeles 64, Calif.

Circle **492** on inquiry card.

Operations Controller. New 4-page Catalog 200 presents Dietz Timed Operations Preselector, a time control device for programming a number of timed operations in preselected sequence.—The Henry G. Dietz Co., 12-16 Astoria Blvd., Long Island City 2, N. Y.

Circle **493** on inquiry card.

Speed-Feed Meter. New 4-page Brochure 1140 describes maker's MF-2 Speed-Feed Meter which measures and indicates linear rates of travel and rpm in machine tools and a variety of applications with push button selection.—Maico Co., Inc., Industrial Div., 21 North 3rd St., Minneapolis 1, Minn.

Circle **494** on inquiry card.

Time Switches. New 2-page Bulletin NR #156 announces the Intermatic "Cycler-12" (Series C8301-S) timer with cycles of operations from 10 seconds to 12 minutes.—International Register Co., 2624 W. Washington Blvd., Chicago 12, Ill.

Circle **495** on inquiry card.

Automatic Counters. New 2-page bulletin describes pneumatic and hydraulic automatic counters available with five or six digits and knob or key reset.—Pneumaticount, 3400 N.E. 54 Ave., Portland 13, Oregon.

Circle **496** on inquiry card.

Tachometer and Counter. New 2-page Bulletin T describes maker's electronic tachometer with four-digit, glow-transfer tube counter designed to test the speed of motors.—Magtrol, Inc., 38 Virginia Place, Buffalo 2, N. Y.

Circle **497** on inquiry card.

Speed Reducer. New 4-page Bulletin 98 describes and types maker's Bantam speed reducers.—Metron Instrument Co., 432 Lincoln St., Denver 3, Colo.

Circle **498** on inquiry card.

Timers. New 2-page bulletin pictures and describes maker's Duplex timer used in industrial applications.—Industrial Timer Instruments Co., 189 W. Madison St., Chicago 2, Ill.

Circle **499** on inquiry card.

Time Switches. New set of bulletins describes and illustrates maker's "Intermatic" Supervisor program time switches.—International Register Co., 2620 W. Washington Blvd., Chicago 12, Ill.

Circle **500** on inquiry card.

GAGING, TESTING, INSPECTION

Mechanical Comparator. New 16-page Circular No. 599 describes maker's Sigmatic mechanical comparator for close tolerance inspection.—Pratt & Whitney Co., Inc., Charter Oak Blvd., West Hartford 1, Conn.

Circle **501** on inquiry card.

Thickness Control. New 12-page Bulletin B-1556 presents AccuRay strip thickness control systems for the ferrous and non-ferrous metal-working industry.—Industrial Nucleonics Corp., 1205 Chesapeake Ave., Columbus 12, Ohio.

Circle **502** on inquiry card.

Precision Inspection Flats. New 78-page Technical Manual (Third Edition) describes maker's granite surface plates.—Collins Microflat Co., 2326 E. 8th St., Los Angeles 21, Calif.

Circle **503** on inquiry card.

Dimensional Control. Wall chart shows the five echelons of accuracy for dimensional control—production, inspection, gage laboratory, gage-laboratory standards, and metrology laboratory, with a checklist for appraising accuracy in dimensional measurement—workpiece, instrument, standard, environment and human element.—The Sheffield Corp., Dayton 1, Ohio.

Circle **504** on inquiry card.

Comparator. New 2-page bulletin presents portable, universal length-and-width comparator for checking work in progress and completed jobs. Accuracy within 0.0001".—Jerpbak-Bayless Co., Solon Rd., Solon, Ohio.

Circle **505** on inquiry card.

Circuit Testing. New 4-page brochure presents plugboard programming for maker's new Multiplier Sections to simplify the pre-test preparation and actual test process in tests involving more than 200 circuits. Plugboard replaces adapter cables.—Dit-Mco, Inc., 911 Broadway, Kansas City 5, Mo.

Circle **506** on inquiry card.

NUCLEONICS

Nuclear Products Division. New 6-page Bulletin 200 presents the products, fabrication services and facilities of Superior Tube Company's Nuclear Products Division.—Superior Tube Co., Norristown, Pa.

Circle **507** on inquiry card.

Nuclear Power Plants. New 12-page bulletin presents supply of ALCO Products' packaged atomic power plants for competitive power in isolated regions etc.; also complete atomic plants; reactors for power and research; nuclear power station components.—ALCO Products, Inc., P. O. Box 1065, Schenectady, N. Y.

Circle **508** on inquiry card.

DATA PROCESSING

Data Processing. New 16-page Bulletin 32-6967 presents case studies of production control with random access memory and punched card, special industry bulletins describe applications in various specialized departments.—International Business Machines Corp., 590 Madison Ave., New York 22, N. Y.

Circle **509** on inquiry card.

Data Processing Analysis Instruments. New 32-page bulletin 1305 illustrates and describes instruments for analysis, control and data processing. Accurate representation of physical phenomena—pressure, strain,

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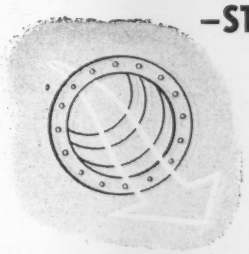
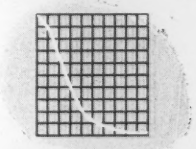
—STILL THE BEST VALVE YOU CAN BUY

Only Rotovalves give you all these features:

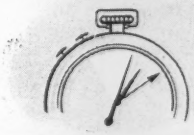


LEAST PRESSURE LOSS
Full line opening means less head loss, lower pumping costs.

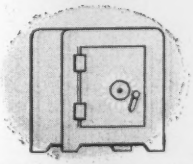
EASIEST TO OPERATE
Hydraulic imbalance and mechanical design mean 1 man can close as fast as required. Less power needed in mechanical or electrical operation.



GREATEST INITIAL SHUT-OFF
Rotovalve 55% closed at 25% stroke, and 92% closed at 50% stroke. In comparison, gate valves only 18% closed at 25% stroke and 43% closed at 50% stroke.



MOST CONTROLLED CLOSING TIME
Closing as quickly as one second or as slow as needed. Fast initial closing limits reversal of flow.



MOST POSITIVE CLOSING
Drop-tight, positive closing. Self-purging, monel-to-monel seating. Pressure-tight bolted head, stuffing box, and machined and lapped seats.

In addition to all these features typical of SMS engineering, Rotovalves have a flexibility that makes them suitable for any type of operation, any method of control, or any sort of location.

For detailed information about SMS Rotovalves, Ball or Butterfly Valves, see our local representative or write to the S. Morgan Smith Company, York, Pennsylvania.

HYDRAULIC TURBINES · GATES & HOISTS · TRASH RAKES · PUMPS · ACCESSORIES

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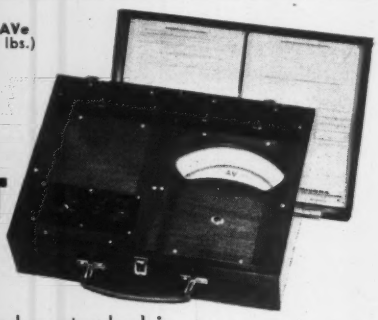
19 RANGES IN ONE PRECISION AC INSTRUMENT

MODEL 1 AVe
(Weight—22 lbs.)



This exceptionally versatile secondary standard is used for exact measurements of voltage and current in laboratories, and other installations.

11 CURRENT RANGES

5—10—20—50—100—200—500 milliamps
1—2—5—10 amps
Consumption—about 0.7 VA for full deflection

8 VOLTAGE RANGES

5—10—20—50—100—200—500—1000 volts

ACCURACY ±0.2%

Movement—iron shielded Electrodynamometer type internal resistance
10—20—100—500—2000
10.000 . 50.000 . 100.000 OHMS.
6" hand drawn anti-parallax mirror scale.
Case—Polished hardwood

This and other precision instruments made by NORMA in VIENNA, AUSTRIA, Europe's leading manufacturers of electrical instruments are now being introduced by

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For more information circle **165** on inquiry card.

NEW LITERATURE

vibration, acceleration, temperature, current—permanently recorded for correlations with each other and time.—Consolidated Electrodynamics Corp., 300 North Sierra Madre Villa, Pasadena, Calif.

Circle **510** on inquiry card.

Linear Programming. New AIEE Technical Reprint No. 110 presents analog computer techniques and procedures for solving linear programming problems encountered in operations research, game theory, logistics, etc., employing standard computer components.—Reeves Instrument Corp., 207 E. 91st St., New York 28, N. Y.

Circle **511** on inquiry card.

Data Processing System. New 8-page Brochure RA8089 describes latest features of the Elecom 125 Business Data Processing System with internal memory size up to 10,000 words, buffering of magnetic tape on both input and output, a high-speed line printer, a simultaneous collate-select-separate operation on the File Processor, and others.—Underwood Corp., Electronic Computer Div., 35-10 36th Ave., Long Island City 6, N. Y.

Circle **512** on inquiry card.

Data Processing. New 4-page Bulletin 3205A presents Electronic Data Processing Systems consisting of Datatron Digital computer, Cardatron punched-card, or Datareader magnetic tape input-output; and auxiliary equipment.—ElectroData Corp., 460 Sierra Madre Villa, Pasadena, Calif.

Circle **513** on inquiry card.

Digital Systems Indicator. New 2-page Preliminary Data Sheet E-ND46(101) describes the "Speedomax" H Model R Indicator for Digital Systems, involving simultaneous or sequential readout; also gives specifications.—Leeds & Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.

Circle **514** on inquiry card.

OPTICAL

Marco and Micro Photography. New 48-page Booklet P.S.A. 656 describes and illustrates applications for 35mm camera in macro and micro photography as a technical recording tool.—Karl Heitz, Inc., 480 Lexington Ave., New York 17, N. Y.

Circle **515** on inquiry card.

Solar Ephemeris. New 96-page Booklet "Solar Ephemeris for 1957" features charts that simplify the computation of Polaris, an Almanac, charts for the sun and Polaris, definitions of astronomical terms and sample problems.—W. & L. E. Gurley, Troy, N. Y.

Circle **516** on inquiry card.

Optical Parts. New 16-page Catalog L-117 offers information on a wide variety of special lenses, prisms and reflectors for industrial use; also ground glass, heat absorbing glass, retardation plates, the B&L precision glass engraving and optical coating services.—Bausch & Lomb Optical Co., 635 St. Paul St., Rochester, N. Y.

Circle **517** on inquiry card.

Optical Tooling. New 20-page Booklet A2230 explains with illustrations theory, principles, and practice of optical tooling; also describes complete line of Brunson optical tooling instruments and accessories.—Distributed by Charles Bruning Co., Inc., 4700 Montrose Ave., Chicago 41, Ill.

Circle **518** on inquiry card.

ANALYTICAL, LABORATORY

Laboratory Equipment. New 16-page "Newsletter" (Vol. 3, No. 1) describes many new instruments including the Gardner-Balinkin Ceramic Density Penetrometer, the Burnay Electric Bunsen Burner, and maker's Large-Area Colorimeter, etc.—Gardner Laboratory, Inc., P. O. Box 5728, Bethesda 14, Md.

Circle **519** on inquiry card.

X-Ray Diffraction. New 2-page Bulletin "Evaluating Alloys by X-ray Diffraction" describes method used to analyze titanium and other alloys.—North American Philips Co., Inc., 750 So. Fulton Ave., Mt. Vernon, N. Y.

Circle **520** on inquiry card.

Infrared Analyzers. New 8-page Bulletin No. 0705-2 presents maker's 2 models LIRA infrared analyzers for selective, sensitive, high-speed analysis of complex gas or liquid streams.—Mine Safety Appliances Co., 210 No. Braddock Ave., Pittsburgh 8, Pa.

Circle **521** on inquiry card.

Paper Electrophoresis. New 4-page Bulletin 4-CP presents the new continuous-flow paper electrophoresis system Spinco Model CP, especially suited for proteins, dyes, pharmaceuticals, etc.—Spinco Div., Beckman Instruments, Inc., 688 O'Neill Ave., Belmont, Calif.

Circle **522** on inquiry card.

Control by Stream-Analysis. New 8-page Reprint R-88 of article "New Applications of Devices for Automatic Control" presents advantages and disadvantages of the various types of process stream analyzers.—Scientific Instruments Div., Beckman Instruments, Inc., Fullerton, Calif.

Circle **523** on inquiry card.

Photoelectric Colorimeter. New 6-page bulletin describes imported Model VI photoelectric colorimeter with filter casette for rapid changing of color filters.—Epic, Inc., 154 Nassau St., New York 38, N. Y.

Circle **524** on inquiry card.

Lab Equipment. New 64-page Supplement Labalog 956 presents many new instruments added to maker's stock along with current price list and specification revisions.—Schaar and Co., 754 W. Lexington St., Chicago 7, Ill.

Circle **525** on inquiry card.

MONITORS

Annunciators. New 32-page Catalog 100 B presents maker's complete line of standard, integrated Panalarm Annunciator Systems for industry; operating sequences, specs, and performance features of specific types.—

Panellit, Inc., 7401 North Hamlin Ave., Skokie, Illinois.
Circle **526** on inquiry card.

Switch Check. New 4-page bulletin presents maker's "Switcheck" that uses neon lamp to signal when a switch is open.—Doyle Design & Machine Co., 51 Scio St., Rochester, N. Y.
Circle **527** on inquiry card.

Neon Indicating Light. New 2-page bulletin describes small size neon indicating light that mounts in ⅜" dia hole from rear of panel.—Drake Mfg. Co., 1713 W. Hubbard St., Chicago 22, Ill.
Circle **528** on inquiry card.

Alarm. New 2-page Bulletin 756 describes "Larm-Tector" with indicating alarm light and delayed alarm buzzer.—Way-Wolff Associates Inc., 33 Fulton St., New York 38, N. Y.
Circle **529** on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

Signal Generator. New 8-page folder describes the new Signal Generator and Control System designed to meet the varied requirements of a signal source for electrical, electro-acoustical and acoustical measurements.—Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio.
Circle **530** on inquiry card.

Oscilloscope. New 2-page bulletin presents specifications for maker's Type 329-A precision oscilloscope.—Technical Sales Dept., Allen B. DuMont Labs., Inc., 760 Bloomfield Ave., Clifton, N. J.
Circle **531** on inquiry card.

Electronic Instruments. New 48-page 1957 catalog describes maker's line of sweeping oscillators, marker generators, signal generators, sound and vibration analysis equipment, voltmeters, etc.—Kay Electric Co., 14 Maple Ave., Pine Ave., Pine Brook, N. J.
Circle **532** on inquiry card.

Light Spot Wattmeter. New 4-page bulletin describes imported precision light spot wattmeter with ± 0.1% limit of error and 270mm scale length.—Epic, Inc., 154 Nassau St., New York 38, N. Y.
Circle **533** on inquiry card.

Precision Calibrator. New 4-page bulletin presents the Nabors Model 51 precision calibrator for dc-meter calibration or use as calibrated voltage or current supply.—Thomas L. Stevens Co., 5333 So. Sepulveda Blvd., Culver City, Calif.
Circle **534** on inquiry card.

Electronic Standard Instruments. Five new technical bulletins present company's latest standard instruments—Bull. 180 the Model 58-AS VHF Radio Noise and Field Strength Meter; Bull. 179 the Model 84-TVR UHF Standard Signal Generator; Bull. 178 the Model 202-C Standard Barretter Bridge for RF voltage and power; Bull. 178 the model 210 Series FM Standard Signal Generators; and Bull. 176 the Model 505 Standard Test Set for Transistors.—Measurements Corp., Boonton, N. J.
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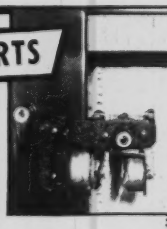

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Tensitron, Inc., Harvard, Mass.

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NEW LITERATURE

Panel Meters. New 2-page Engineering Data Sheet 230 describes maker's new line of 1" Round Flush Mounting Panel Meter Model 104; gives specifications, standard ranges and maximum resistances, and dimensional data.—International Instruments, Inc., New Haven 15, Conn.

Circle **536** on inquiry card.

I.F. Amplifiers. New 4-page brochure illustrates and describes line of I.F. amplifiers and preamplifiers using miniature and sub-miniature tubes, including laboratory type units.—LEL, Inc., 380 Oak St., Copiague, L. I., N. Y.

Circle **537** on inquiry card.

Pulse Generator. New 4-page Bulletin B-3 presents maker's Pulse Generator with repetition rates through one megacycle and continuous control of pulse width, repetition rate, and delay.—Rutherford Electronics Co., 3707 S. Robertson Blvd., Culver City, Calif.

Circle **538** on inquiry card.

Voltmeters/Microammeters. New 8-page catalog presents maker's line of sensitive meters for d-c and a-c measurements, and a wide selection of ranges.—Greibach Instruments Corp., Metuchen, N. J.

Circle **539** on inquiry card.

POWER SUPPLIES

Power Supply. New Model 2500 Voltage Regulated Power Supply features a 0-2500 volt, 0-50 ma continuous duty dc output with low ripple, fast recovery time, good stability, and low output impedance.—Kepco Labs., 131-38 Sanford Ave., Flushing 55, N. Y.

Circle **540** on inquiry card.

Custom Power Supplies. New 9-page "Custom Design File" presents special power supplies—Series-Tube-Regulated, Constant-Current, Unregu-

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lated High Voltage Power, etc., including data on voltage, current, ripple, etc., and price.—NJE Corporation, 345 Carnegie Ave., Kenilworth, N. J.

Circle **541** on inquiry card.

Power Supply. New 2-page pamphlet available on Model 109 A.C. Metered Variable Transformer which features a fuse protected variable autotransformer, a neon pilot light, and a well legible 4½" voltmeter with an essentially linear scale.—Slaughter Co., Piqua, Ohio.

Circle **542** on inquiry card.

Pressure Regulators. New 4-page Bulletin F-15A presents precision air pressure regulators in sizes ⅛" to ½"; air filters; air lubricators; and combination units.—Watts Regulator Co., Lawrence, Massachusetts.

Circle **543** on inquiry card.

Power Supplies. New 2-page Bulletin No. 103 illustrates and describes maker's Model KM95B Dual Range D. C. Power Supply, for bench mounting and Model KM95 for rack mounting.—Opad Electric Co., 69 Murray St., New York 7, N. Y.

Circle **544** on inquiry card.

ITV

Industrial TV. New 4-page brochure on GPL ii-Tv (Industrial and Institutional Television).—General Precision Lab., Inc., Pleasantville, N. Y.

Circle **545** on inquiry card.

ITV Equipment. New 4-page bulletin DP-96 presents TV equipment including closed-circuit camera, boosters, converters, amplifiers, connectors, tapoffs, filters, attenuators, equalizers, etc.—Blonder-Tongue Labs., Inc., Westfield, N. J.

Circle **546** on inquiry card.

ELECTRONIC COMPONENTS

Instrument Transformers. New 12-page Bulletin GED-3112 contains information on a complete line of nine Butyl-molded instrument transformers from 600 V through 15 KV.—General Electric Co., Schenectady, N. Y.

Circle **547** on inquiry card.

Electromechanical Transducers and Systems. New 16-page catalog presents products of company's divisions such as accelerometers and interferometers; thermistors and thermal controls; magnetic power supplies; ultrasonic equipment for cleaning, soldering, non-destructive testing; temperature capacitors, packaged circuits; panel meters; and cathode ray recorders and error computers.—Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J.

Circle **548** on inquiry card.

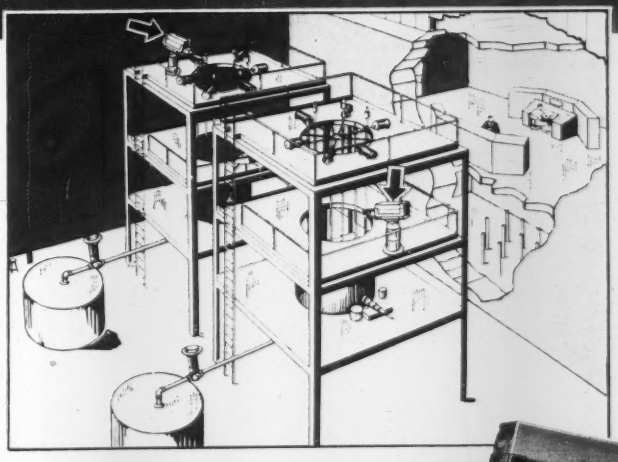
Capacitors. New 2-page Sprague Electric Engineering Bulletin 320A presents maker's Littl-Lytic subminature electrolytic capacitors whose maximum rated operating temperatures have been increased to 85°C.—Technical Literature Section, Sprague Electric Co., 43 Marshall St., North Adams, Mass.

Circle **549** on inquiry card.

Capacitors. New 44-page annual 1957 Replacement Capacitor Catalog

Diamond "UtiliVue" (WIRED TELEVISION)

used in NUCLEAR REACTOR STUDIES at Battelle Memorial Institute



Arrows indicate remotely controlled "UtiliVue" Cameras that SEE experimental nuclear reactor cores.

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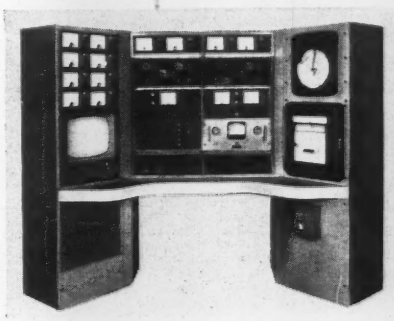

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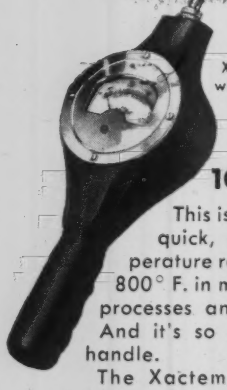

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NEW LITERATURE

200D-3 covers electrolytic, paper tubular, industrial, mica, ceramic, filter, and motor-start capacitors.—Cornell-Dubilier Electric Corp., South Plainfield, N. J.

Circle **550** on inquiry card.

Silicon Rectifiers, Diodes. New 4-page Bulletin TE 1351 describes high temperature silicon rectifiers and includes two 4-page bulletins on current ratings.—Nine 2-page bulletins describe types and models of silicon rectifiers: 6-page Bulletin TE 1342 describes silicon rectifier stacks: 4-page Bulletin TE 1350 describes high temperature silicon diodes.—Transitron Electronic Corp., Wakefield, Mass.

Circle **551** on inquiry card.

Electronic Equipment. New 12-page brochure presents maker's electronic components such as flashers, sensors, protective devices, relays, time delay relays, repeat cycle relays, missile fuses, also specialty devices, test equipment, RF systems and components.—Electronic Specialty Co., 5121 San Fernando Rd., Los Angeles 39, Calif.

Circle **552** on inquiry card.

Terminal Blocks. New 8-page Catalog No. 556 presents Curtis Terminal Blocks and Terminal Block Kits including technical description, specifications and prices. Also a new Selector Chart.—Curtis Development & Mfg. Co., 3250 No. 33rd St., Milwaukee 16, Wis.

Circle **553** on inquiry card.

SWITCHES, RELAYS

Switches. Two new 2-page Data Sheets describe 3-light pushbutton switch (No. 110) and 3-position rotary-actuated toggle switch (No. 113).—Micro Switch, Div. of Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Circle **554** on inquiry card.

Sub-Miniature Switches. New 2-page Engineering Data Sheet 237-1 describes sub-miniature lever switches—Series L7000 Lever Switch and Series SRL7000 Spring Return Lever Switch with electrical characteristics, specifications and mounting dimensions.—International Instruments, Inc., P. O. Box 2954, New Haven 15, Conn.

Circle **555** on inquiry card.

Static Switching Systems. New 8-page Bulletin GEA-6364 presents the operation of maker's static switching systems for automation whose advantages include reduced downtime, easy maintenance, reduced inspection and replacement, and minimized atmospheric problems.—General Electric Co., Schenectady 5, N. Y.

Circle **556** on inquiry card.

Relays and Switches. New 11-page catalog on maker's relays and switches shows a variety of approximately forty different types from standard to miniature sizes.—Jaidinger Mfg. Co., 1921 W. Hubbard St., Chicago 22, Ill.

Circle **557** on inquiry card.

Time Delay Relays. New Bulletin AWH TD403 presents details of the function of maker's three basic Time Delay Relays, standard ranges (1½ seconds to 90 minutes).—The A. W. Haydon Co., Waterbury, Conn.

Circle **558** on inquiry card.

Mercury Relays. New 24-page loose leaf Catalog 154 furnishes complete information (also price list) on maker's high-quality, low-cost merc-

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420	445	470	495	520	545	570
421	446	471	496	521	546	571
422	447	472	497	522	547	572
423	448	473	498	523	548	573
424	449	474	499	524	549	574
425	450	475	500	525	550	

For further details on products reported in

- **Advertisements**
- **New Instruments**
- **Briefs**
- **New Literature**

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Dec. '56

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Company .....

Company Address ..... **City** ..... **Zone** ..... **State** .....

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Advertised Products

1	26	51	76	101	126	151
2	27	52	77	102	127	152
3	28	53	78	103	128	153
4	29	54	79	104	129	154
5	30	55	80	105	130	155
6	31	56	81	106	131	156
7	32	57	82	107	132	157
8	33	58	83	108	133	158
9	34	59	84	109	134	159
10	35	60	85	110	135	160
11	36	61	86	111	136	161
12	37	62	87	112	137	162
13	38	63	88	113	138	163
14	39	64	89	114	139	164
15	40	65	90	115	140	165
16	41	66	91	116	141	166
17	42	67	92	117	142	167
18	43	68	93	118	143	168
19	44	69	94	119	144	169
20	45	70	95	120	145	170
21	46	71	96	121	146	171
22	47	72	97	122	147	172
23	48	73	98	123	148	173
24	49	74	99	124	149	174
25	50	75	100	125	150	175

New Instruments

201	226	251	276	301	326
202	227	252	277	302	327
203	228	253	278	303	328
204	229	254	279	304	329
205	230	255	280	305	330
206	231	256	281	306	331
207	232	257	282	307	332
208	233	258	283	308	333
209	234	259	284	309	334
210	235	260	285	310	335
211	236	261	286	311	336
212	237	262	287	312	337
213	238	263	288	313	338
214	239	264	289	314	339
215	240	265	290	315	340
216	241	266	291	316	341
217	242	267	292	317	342
218	243	268	293	318	
219	244	269	294	319	
220	245	270	295	320	
221	246	271	296	321	
222	247	272	297	322	
223	248	273	298	323	
224	249	274	299	324	
225	250	275	300	325	

New Literature

401	426	451	476	501	526	551
402	427	452	477	502	527	552
403	428	453	478	503	528	553
404	429	454	479	504	529	554
405	430	455	480	505	530	555
406	431	456	481	506	531	556
407	432	457	482	507	532	557
408	433	458	483	508	533	558
409	434	459	484	509	534	559
410	435	460	485	510	535	560
411	436	461	486	511	536	561
412	437	462	487	512	537	562
413	438	463	488	513	538	563
414	439	464	489	514	539	564
415	440	465	490	515	540	565
416	441	466	491	516	541	566
417	442	467	492	517	542	567
418	443	468	493	518	543	568
419	444	469	494	519	544	569
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421	446	471	496	521	546	571
422	447	472	497	522	547	572
423	448	473	498	523	548	573
424	449	474	499	524	549	574
425	450	475	500	525	550	

NEW LITERATURE

ury plunger relays and related products, including the new 20-amp rated midget Minirelay.—Ebert Electronics Corp., Queens Village 28, N. Y.

Circle **559** on inquiry card.

POTENTIOMETERS, RESISTORS

Non-linear Potentiometers. New 4-page Data Sheet 54-74 presents seventy-five standard-model non-linear potentiometers. New 2-page Data Sheet 54-34 presents standard specifications for four new single-turn precision potentiometers.—Helipot Technical Information Service, Newport Beach, Calif.

Circle **560** on inquiry card.

Potentiometers. New 2-page Bulletin 205/6/1 announces the Model 205 Trimpot—a subminiature unit with round-pin terminals for printed circuit applications, includes specifications and dimensions.—Bourns Labs., Inc., 6135 Magnolia Ave., Riverside, Calif.

Circle **561** on inquiry card.

Precision Potentiometers. Two new brochures (4-page Technical Bulletin 63 and 2-page Technical Bulletin 64) present illustrations and data on "Electromath" high precision potentiometers, linear and non-linear.—Electromath Corp., 190 Henry St., Stamford, Conn.

Circle **562** on inquiry card.

Voltage Divider. New 2-page bulletin presents Voltage Divider VDR-106 with accuracy of 0.0001%.—Julie Research Labs., Inc., 556 W. 168th St., New York, N. Y.

Circle **563** on inquiry card.

TRANSISTORS, TUBES

Silicon Junction Diodes. New 2-page bulletin describes maker's new quick-recovery silicon junction diodes—high-speed, high-voltage, high-temperature devices for most high frequency or fast switching circuits.—Hughes Products, Div. of Hughes Aircraft Co., International Airport Station, Los Angeles 45, Calif.

Circle **564** on inquiry card.

Vacuum Tubes. New 24-page booklet PG101C presents RCA Power & Gas Tubes including technical data on 175 types: Vacuum power tubes—air-cooled, forced-air-cooled, and water-cooled, rectifier tubes—vacuum, mercury-vapor, and gas; thyratrons—gas and mercury-vapor; ignitrons; magnetrons; and vacuum-gauge tubes. —Commercial Engineering, RCA Tube Div., Harrison, N. J.

Circle **565** on inquiry card.

CONNECTORS, WIRE

Coaxial Terminations. New 2-page Bulletin 46 describes coaxial terminations for dc to 10 kMc; 2-page Bulletin 54 describes power bridges and attenuators.—Weinschel Engineering, 10503 Metropolitan Ave., Kensington, Md.

Circle **566** on inquiry card.

Wire Harnesses. New 2-page leaflet presents "Zippertubing"—flat strips of plastic, with patented beads on edges, that wraps around wires and zips shut.—W. A. Plummer Mfg. Co., 752 S. San Pedro St., Los Angeles 14, Calif.

Circle **567** on inquiry card.

Spaghetti Tubing. New 2-page bulletin Birflon T-500 covers new thin wall Teflon tubing, used as sheathing, insulation for bare wires, connection of components, etc.—Birnbach Radio Co., Inc., 145 Hudson St., New York 13, N. Y.

Circle **568** on inquiry card.

TUBING

Tube Cutter. New 2-page Bulletin No. 3057 features new Imperial 2-in-1 Tube Cutter with Spare Cutting Wheel concealed in a recess behind the reamer.—The Imperial Brass Mfg. Co., 1200 W. Harrison St., Chicago 7, Ill.

Circle **569** on inquiry card.

Tubing and Tubular Components. New 4-page general catalog covers maker's line of small seamless tubing and small tubular components, including pointer tubing and metal-shielded wire.—Uniform Tubes, Inc., 1200 Level Rd., Collegeville 2, Pa.

Circle **570** on inquiry card.

Acrylic Products. New 4-page bulletin presents maker's acrylic (Lucite and Plexiglas) rods, tubes and shapes, and tabulates physical properties.—Ace Plastic Co., 91-30 Van Wyck Expressway, Jamaica 36, N. Y.

Circle **571** on inquiry card.

MECHANICAL COMPONENTS

Stock Gears and Pinions. New GRC Stock Gear and Pinion bulletin lists die-cast zinc alloy gears and pinions available.—Gries Reproducer Corp., 125 Beechwood Ave., New Rochelle, N. Y.

Circle **572** on inquiry card.

Mechanical Push-Pull Control. New 4-page bulletin presents Controlex flexible push-pull remote control moving on ball bearing.—Controlex Corporation of America, Westchester County Airport, White Plains, N. Y.

Circle **573** on inquiry card.

Ball Bearings. New 64-page Precision Ball Bearings Catalog presents standard bearings, special designs, gyro bearings, performance data, selection and engineering data.—The Barden Corp., Danbury Connecticut.

Circle **574** on inquiry card.

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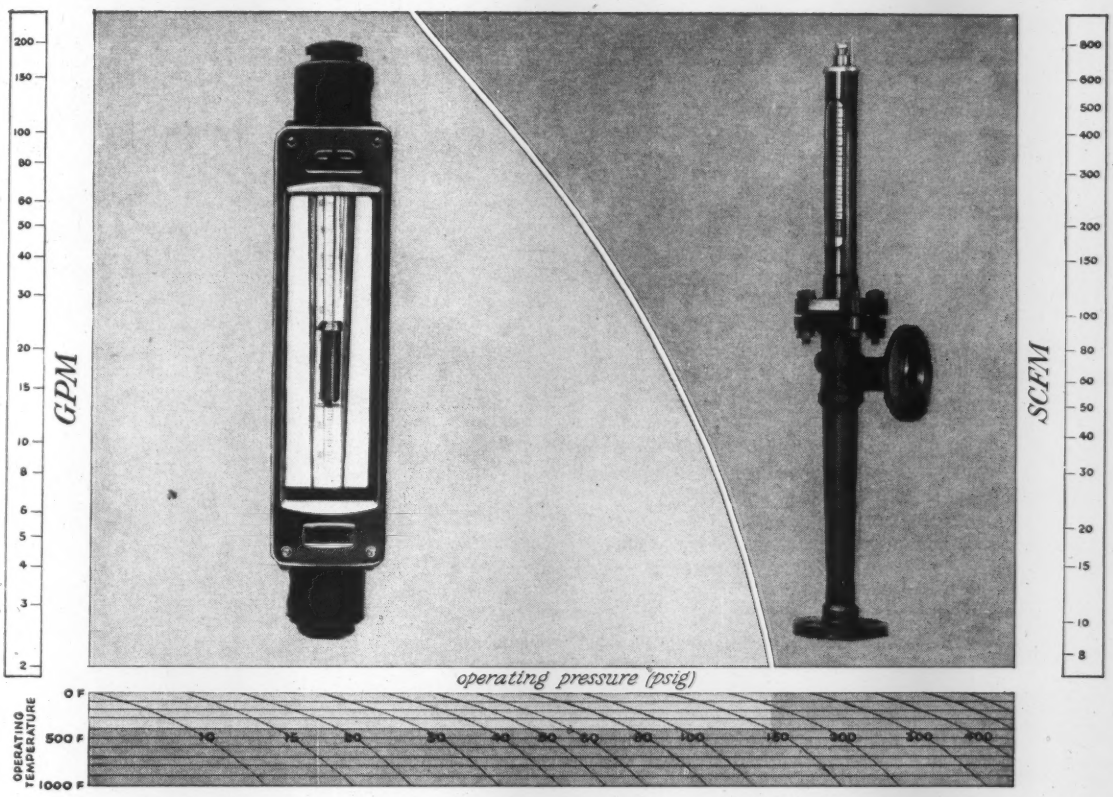


For all flow measuring problems...

F & P HAS THE ANSWER

Corrosive fluids or gases, corrosive atmospheres, high temperatures and high pressures are common flow measuring problems... and they're being solved every day with Fischer & Porter flowmeters.

Two of the most popular types of F&P flowmeters are the 1700 Series Flowrator meter and the all-metal Fig. 52 armored Flowrator meter. These versatile meters give you a predictable calibration performance in all ranges doing away with the necessity of individual calibration. You can get maximum corrosion resistance because both meters are available in many different materials.

Here are just a few of the features of the 1700 Series flowmeters:

Stainless steel enclosure standard Eliminates costly maintenance because corrosive atmospheres are no problem.

Three designs in one basic instrument Side plate construction gives extra rigidity and prevents operating stresses and strains from being transmitted to the tube . . . standard enclosure gives extra protection against accidental tube breakage . . . pressure enclosure gives maximum protection.

End fittings rotate 360° Simplifies piping arrangement.

Built-in panel mounting fittings Longer bolts are all that is needed for front or rear panel mounting.

Controlled outside tube diameter Permits the use of *molded* teflon liner and pre-cut packing rings interchangeable within meter size.

The Fig. 52 armored Flowrator meter is another favorite of industry. Here's why:

Cold-formed metering tubes Unique cold forming of precision-bore metal metering tubes eliminates price differential between glass tube flowmeters and all-metal flowmeters . . . assures complete interchangeability of metering tubes.

150 lb. and 300 lb. flanges standard Eliminates any problem in the matching of flanges.

Only one moving part Minimizes maintenance and pressure drop.

This is only part of the story on what F&P flowmeters can do for your process. To get all the details on 1700 Series and Fig. 52 Flowrator meters, write to Fischer & Porter Co., 426 County Line Road, Hatboro, Penna.

Catalogs on other F&P flowmeters

10-A-10—Introduction to F&P Flowrator meters
10-A-43—High capacity Flowrator meters
10-A-93—Selection Guide for Flowrator meters

FP FISCHER & PORTER CO. Hatboro, Pa.

COMPLETE PROCESS INSTRUMENTATION

For more information circle **174** on inquiry card.

CONTROL VALVES

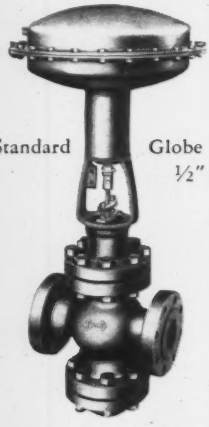
designed for:

LARGE FLOWS

(dP up to 3600 PSI)

Venturiflo Angle Valve 1" - 12"

GENERAL PURPOSE



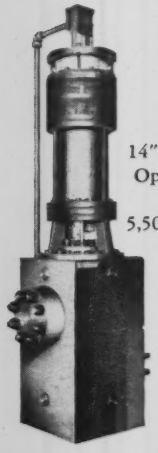
Standard Globe Valve ½" - 16"

SMALL FLOWS

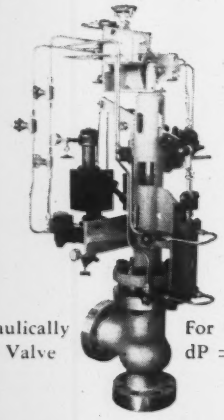
(From Cv Max. = 12 To Cv Max. = 0.0000(0)

MicroFlo Angle Valve ½" - 1"

OR YOUR SPECIAL APPLICATIONS



14" Magnetically Operated Valve For 5,500 PSI Service



8" Hydraulically Operated Valve

For Gas Service dP = 2230 PSI

6" Spring-Loaded - Piston Operated Valve

For 600 PSI Steam @ 750°F.

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For more information circle **175** on inquiry card.